The GISt of GIS

The Geographic Information System Handbook

September 1996

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TransAid Service Center

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This version contains references specific to Washington State. Additional copies of this document may be obtained by contacting:

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Introduction

This handbook's purpose is to help municipalities and other governmental bodies in Washington develop a plan for purchasing and evaluating a Geographic Information System (GIS). According to a survey by the state's Municipal Research and Service Center in February, 1996, only 20 percent of Washington's 275 municipalities use GIS. However, in the same state survey, all of the responding municipalities indicated their use of maps and geographic information was probably frequent enough to warrant automation. The 220 cities in this state without GIS may be potential candidates for evaluating whether such a system is right for their needs.

This handbook is intended to be an easy-to-use resource for cities to quickly identify and evaluate:

- GIS needs;
- whether this technology will assist in delivering services in a more cost-effective, efficient, and responsive manner;
- lingo associated with GIS;
- policy considerations; and
- goals and objectives.

This book will also help cities develop a needs assessment and a request for proposals.

The rationale behind implementing geographic information systems is that inventory and management systems overlap in the information needed to maintain them, just as the infrastructure overlaps in its own physical place (for instance, under the sidewalk will lie gas pipelines and electrical lines). GIS allows the city manager to recognize and take advantage of these overlapping infrastructures and gain economies of scale by not doing redundant inventories.

In the past, lacking this type of guide, many organizations have spent many millions of dollars to get functional systems. The causes of this cost are many. One is that GIS has traditionally been available only to users of top-end computer systems. Another reason is that when GIS was less widely used, information had to be acquired by each user, requiring extensive survey work. As desktop computer systems rapidly increase their capability, so GIS has increasingly become a desktop program. Hardware has dramatically decreased in cost. For example, color printers have dropped from over $10,000 a few years ago, to the present cost of several hundred dollars. Increasingly, GIS software has become easier to use, less expensive, and the information needed is also increasingly available from a variety of sources. This guide will contain direct reference to specific software applications and vendors. In the rapidly changing world of information systems, alternatives are always available. The reader is encouraged to adapt this manual to their specific needs, choosing vendors based upon cost, effectiveness and/or local agency guidelines.

The most important decisions a municipality will face in pursuing a GIS will be the level of financial commitment, gauging whether there is an appropriate return on investment, and whether the benefits outweigh the costs. This handbook attempts to provide policy-makers and administrators with a methodology to evaluate these critical questions.

What is GIS?

GIS is a computer technology that generates maps and reports about geographically related items such as utility lines, manhole covers, etc. Once automated, specific geographic points and other information can be displayed and manipulated. GIS enables cities to improve planning and decision-making by providing a systematic approach to collecting and managing location information.

As an example, a good map allows the user to determine much information about the world. However, the greater advantage of a GIS is that it allows the user to dynamically display information as needed. It also has the capability of holding much more information about the world than can be displayed in graphic form. As an example, a GIS may include a transportation network. This may be a series of lines representing roadways. This **spatial** component, the lines, will show relationships between segments of the roadway and surrounding geographic features. The **attribute** component may include information hard to show on a map such as surface material, resurface date, speed limit, number of lanes and average daily traffic. Additionally, if a GIS is implemented in a Local or Wide Area Network, the maps and their analyses are available at multiple points of access.

Geographic information systems are important because they allow the manipulation of spatial and attribute data. A GIS allows for investigative inquiry not just about real world objects and events. GIS is supported by such disciplines as geography, cartography, remote sensing, surveying, statistics, operations research, computer science and civil engineering and planning.

Spatial data is available in two types: raster and vector. Most systems can use both. The raster model is an image of ground truth. Examples include digital drawings and digital photographs. Their advantage is that it is generally quite clear what they represent and they demonstrate the relationships between real world objects. Vector images are points, lines and polygons representing real world objects. Their advantage is that they allow network analysis of objects and inherently contain information about the extents of the object on the ground. Examples of how vector data can be used include address matching, vehicle routing and scheduling, location analysis and site selection, evacuation plans, resource management, wildlife habitat analysis, zoning and subdivision plan review, locating underground cables and pipelines, electric network load balancing, and inventories.

The attributes of any object are endless. Users must choose those attributes which are most useful to them. We will pursue this question later.

The five basic questions that a GIS is designed to answer are:

1. Location: What is at...?
2. Condition: Where are...?
3. Trends: What has changed...?
4. Patterns: What spatial problems exist...?
5. Modeling: What if...?

Here are a few acronyms and their definitions that are commonly used when talking about GIS. For a detailed reference to these terms and more, refer to Appendix A.

AM/FM — Automated Mapping/Facilities Mapping: AM/FM is used by utilities and public works engineers to track utility lines, locate public works facilities, and manage facilities.

CAD or CADD — Computer-Aided Drafting or Computer-Aided Drafting and Design: This system, developed primarily for architects and engineers, is a sophisticated, computer-based package that can manage and display drawings that are tied to locations.

LIS — Land Information Systems: LIS uses computer mapping and data base technologies for property management.

Uses of GIS

There are several uses for a GIS, but the basic application is transferring map boundaries into a GIS data base which can be: displayed, manipulated, shared electronically, and reproduced.

It may help to think of GIS applications as a building with several stories. (See the illustrations on pages 6 and 7.) The first level is entering the line work from maps that are associated with geographic points. Generally, this is thought of as applying CADD system software to design and drawing for planning and engineering.

The next level adds data base attributes or information layers that describe the specific boundary or line work, such as:

- zoning information,
- street names,
- street classifications,
- voting district wards and precincts,
- property owners, and
- size of water and sewer pipes.

After transferring map and boundary information, planners and policy-makers are able to ask "what if" questions and model alternative solutions to problems. This "penthouse" level is the ultimate use of a GIS.

There are many other basic and more advanced applications.

Basic Applications

- mapping,
- presenting water and sewer mains,
- setting voting district boundaries,
- establishing fire and police districts,
- engineering and planning functions,
- showing tax parcels and assessments, and
- delineating road networks and bus routes.

More Advanced Applications

- illustrating past and future water and sewer line repairs,
- designing new streets,
- planning water and sewer lines,
- manipulating voting district boundaries to comply with redistricting, and
- determining the best routes for fire calls and police patrols.

Most planners have district uses for a GIS. These may include managing fire calls, police patrols, garbage collection, and transportation. A GIS may result in more effective decision-making and a more efficient distribution of resources. Additionally, there is often a very positive impact on the municipal property assessor, who in the past may have had limited assistance from computer resources. Identifying areas for redevelopment or new development are also important uses. There are software programs which allow municipalities to inventory facilities with GIS for the benefit of fire departments, emergency management, normal planning purposes, etc.

Is GIS Right for Your City?

The applications for GIS have several advantages as well as certain disadvantages.

Advantages

Reducing Duplicated Efforts — This is achieved through drawing and entering data and line work only once. GIS provides for one data base which warehouses common land record information. All municipal departments share this among themselves and with other public and private entities.

Streamlining Records Maintenance — Records can be maintained by only one person and they can be shared, whether they are data based or graphically related.

Improving Decision-making — Better decisions are possible through using graphic technology and the power of a data base to pose "what if" questions, allowing users to create alternative solutions.

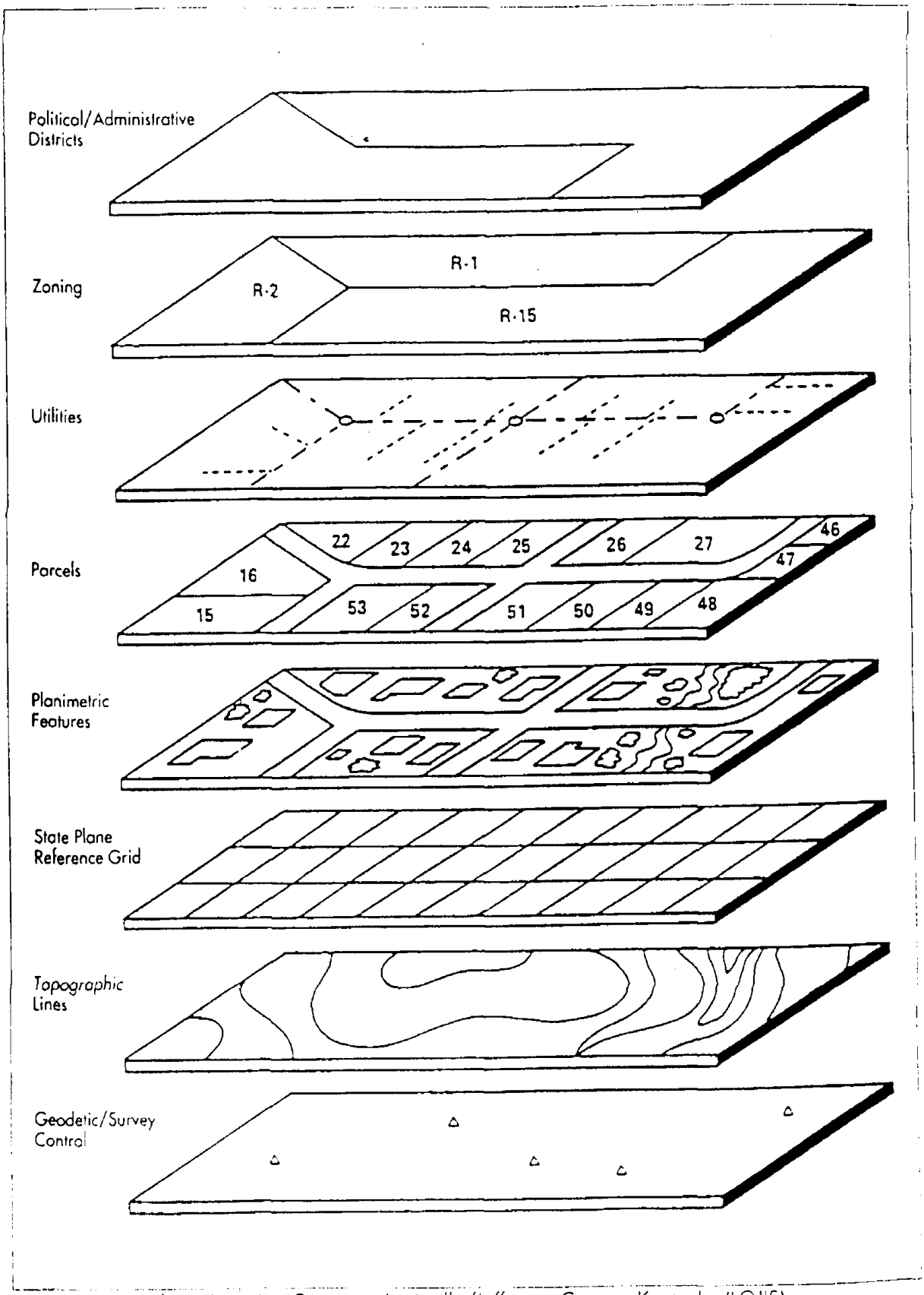
Sharing Information With Agencies and the Public — The key to a successful project is sharing data and graphic information with others. This is a significant advantage of a GIS.

Improving Public Service — Citizens will be able to access information about their property or other geographically related data. This reduces staff time spent fielding these questions from the public.

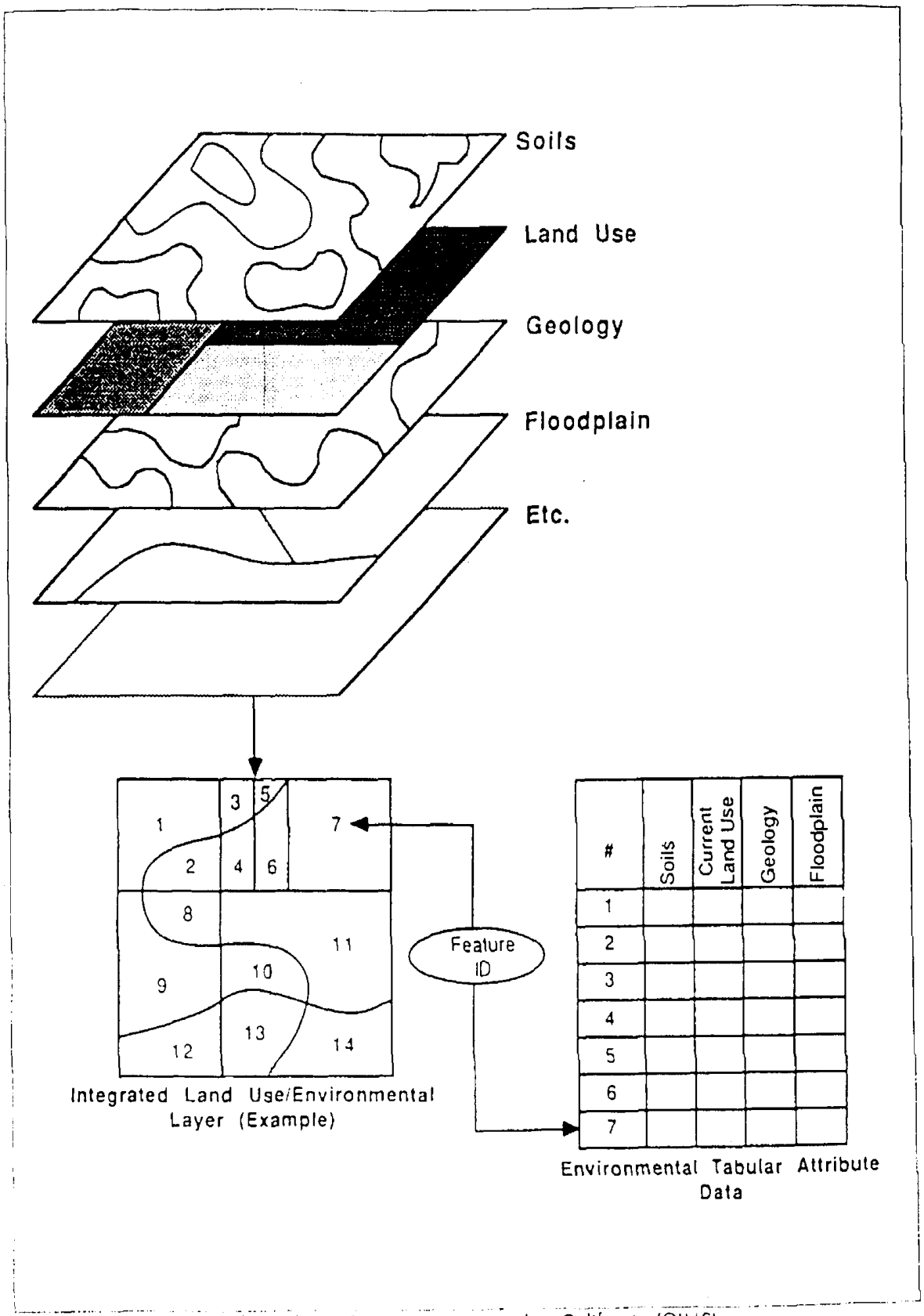
Disadvantages

Money — GIS equipment can range from $25,000 to $100,000 or more for hardware and software. This is a persuasive deterrent for many cities.

Resources — Transferring existing data into a computer data base is labor intensive. For example, it could take an experienced staff several months or even years to develop the basics of a user-friendly operation. This is clearly a long-term process.



Database Layering Concept—Louisville/Jefferson County, Kentucky (LOJIS)



Environmental Database Concept—Los Angeles, California (GIMS)

What Are the Objectives?

In planning a GIS, there are several questions you should ask about your objectives. Will the system's flexibility meet your needs? Is GIS cost effective? Is it necessary to increase data sharing and reduce duplicated efforts? Will GIS expand the private sector's participation? Will customer service and worker productivity be enhanced? Will GIS modernize your land records?

Steps in Planning GIS

There are nine basic steps to planning and implementing a GIS. All are extremely important to a successful program, says *The Local Government Guide to Geographic Information Systems: Planning and Implementation*, published by the International City/County Management Association, the Urban Consortium, and Public Technology, Inc.

1. Obtain top management support.
2. Establish a GIS project team.
3. Conduct a needs assessment.
4. Prepare a preliminary implementation plan.
5. Begin the GIS procurement process.
6. Appoint a selection committee.
7. Request proposals.
8. Evaluate and select vendors.
9. Negotiate and award a contract.

Needs Assessment

While conducting the needs assessment, it will be important to keep the following questions in mind: What are the local government's goals? What are the major technological trends? What limitations will affect implementation? This information is critical, because its accuracy will carry through the entire GIS. The needs assessment committee, usually in conjunction with an outside consultant, should review all activities that may benefit from GIS applications. Appendix B provides a sample needs assessment.

Preliminary Implementation Plan

The preliminary implementation plan not only sets out a schedule for the request for proposals (RFP), vendor selection, and implementation dates, but also provides the following key elements.

- applications, functions, and priorities;
- anticipated immediate results and applications;
- limitations of the system;
- cartographic maintenance record needs and conversion;
- potential sharing with existing hardware and software;

- cost-benefit analysis; and
- project time frame.

Conversion

Converting and maintaining cartographic data are difficult tasks. Before the data base can be used, existing information from maps, land records, and other resources must be entered electronically into the data base. This can be accomplished through one of five major methods.

1. Manual Digitizing — This involves using a digitizer to trace existing maps. This method is slow and the final product is only as good as the original map. Digitizing can be done in-house or through a contract with an outside vendor. Companies now perform this work using robotics. Much of this work is done offshore, but there are stateside vendors.
2. Scanning — This is not yet cost-effective. Basically, portions of the lines have to be drawn over again. However, the cost for this technology is decreasing, so it may be worth investigating.
3. Stereodigitizing Aerial Photographs — Physical land features are mapped by electronic equipment that creates the digital data base from survey-controlled aerial photography. This method can be expensive.
4. Land Surveying and Global Positioning System (GPS) — This is a method of locating points on Earth based on signals from several satellites. These signals allow the greatest degree of positional accuracy and significantly decrease survey time.
5. Purchasing an Existing Data Base — The last option is to purchase an existing data base from an agency such as the Corps of Engineers. However, the data base may not cover all the areas you need or have all the features you want.
6. Public Domain Information — Much of the data collected in Washington State is within the public domain. Costs for obtaining it is generally only the cost of reproduction. Care must be taken to understand the accuracy of the data.

Cost-Benefit Analysis

GIS hardware can range from $7,000 for a small desktop microcomputer system to $15,000 to $25,000 for networked work stations. Software can run from $1,000 to $10,000 for micro-computer-based software, to $15,000 to $20,000 per work station.

All of this adds up, but the big costs are for data acquisition and preparation, which can easily total 70 to 85 percent of the total project budget. (For specific costs and specifications of different Washington municipalities, refer to Appendix C.) These costs include:

Acquisition of Current Aerial Photogrammetry — This can range from $5,000 to $10,000 per square mile, and the price increases as the required accuracy level increases.

Digitizing Planimetric Features and Land-parcel Boundaries — Digitizing property maps can range from $5 to $15 per parcel. The total cost for Indianapolis was $21 per parcel, Pittsburgh spent $20 per parcel, and Dallas has budgeted $30 per parcel. These larger city costs may not be applicable to smaller towns in Washington.

Staff Time — This includes time spent on map preparation and accuracy checking.

The cost-benefit analysis may be as simple as weighing the cost of contracts with engineering firms against the cost of buying equipment and performing the services in-house. Many governments have engaged in cost-benefit analyses to determine whether the expenditures will produce a viable return on their investment. Cincinnati's cost-benefit analysis proved that the break-even point for its system was in the eight year of a 15-year period. One effective way to develop a cost-benefit analysis is to calculate the costs and benefits per year over a 15-year cycle, as illustrated below. However, your actual cycle may be different.

GIS Specifications and Costs

Hardware

One work station server: $17,150
Three work stations: $18,900
Nine 486 33 personal computers with dot matrix printers: $48,510
Two laser printers: $1,500
Monochrome electrostatic plotter: $15,900
Digitizing tablet: $2,100

Subtotal: $104,060

Software

CADD Software: $31,850
Software applications: $21,000
Other applications: $10,520

Subtotal: $63,370

Training and Support

Training and support: $23,110

Subtotal: $23,110

Furniture and Wiring

Furniture and wiring: $15,000

Subtotal: $15,000

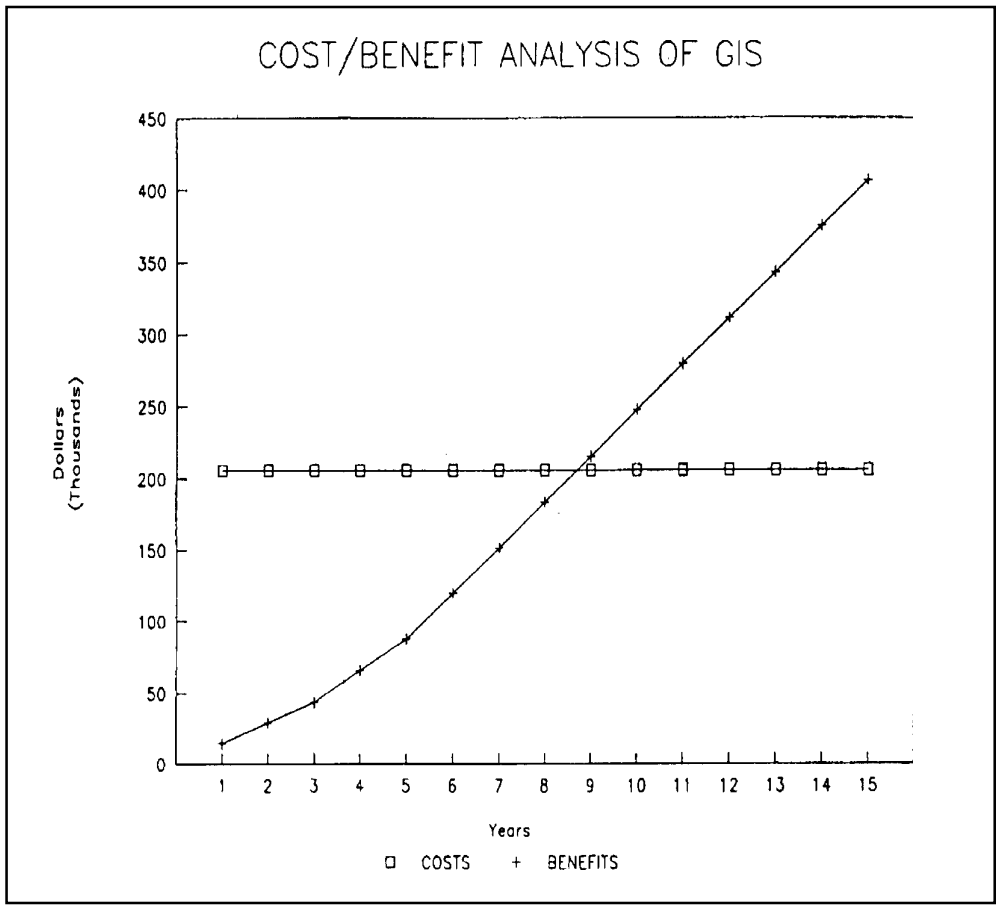
Total $205,540

City population 50,000; all in-house engineering and planning

GIS Benefits

Hours saved over 15 years total 21,868. Computed at $18.57 per hour, savings/benefits cumulative total is $406,410.

The following graph illustrates the break-even point of a GIS. The costs are taken from the chart on page 15, with future costs not depicted.



How to Save Money

Local governments can minimize costs and enhance revenues by:

- doing a pilot project;
- sharing conversion work with other agencies;
- starting small, such as a CADD, but making sure this acquisition is flexible enough to add on a GIS later;
- thoroughly planning on the front end to save money in the long-run;
- purchasing a flexible and adaptable system;
- phasing-in the system;
- charging fees to recover a portion of the cost;
- applying for state funds or federal funds if they are available; working with the local planning office; and
- selling a portion of the municipality's data base to utilities for cash or a portion of the utility's automated data base contingent on public domain laws.

Request for Proposals

The Request for Proposals (RFP) is a direct result of the needs assessment and the committee's implementation plan. Preparing the RFP can be time-consuming, because RFPs cover the full gamut: hardware and software, cartographic data conversion services, data base design, applications development, consulting services, and training.

RFPs focus on two tracks: function and specifications. RFPs primarily focused on function return a flexible response and do not tie the committee to a single software or hardware solution. Before you begin, see what's available from the state bid list, because GIS software applications such as ARC/INFO and other ESRI (Environmental Systems Research Institute, Inc.) products have recently been added to the state's list.

Most RFPs contain the following sections:

- background information,
- description of the local government,
- an inventory of existing equipment and data bases,
- an outline of the purchasing time table,
- the needs analysis and time table,
- description of the evaluation process,
- clarification of the role of vendors,
- definitions and terminology,
- an outline for vendors to follow in submitting their responses,
- contractual requirements.
- vendor's background,
- requirements for responding, and
- pricing by levels, tiers, or phases.

Appendix D provides a sample RFP and Appendix E provides a limited listing of potential vendors.

Evaluating and Selecting Vendors

Evaluating and selecting vendors can usually be done in an objective manner if you have a well-defined process and established criteria. All responses which do not meet the minimum qualifications can be discarded.

Once a short-list of vendors has been derived, interviewing can begin. During the interviewing phase, it is extremely important to clarify responses and determine if and how the vendor can meet the obligations. References will play a vital role in this part of the analysis. Appendix F provides a short scorecard which Catawba County, N.C., used to evaluate interview responses.

Policy Considerations

There are three major policy considerations that need special attention when contemplating a GIS: the scope of the system, public access to records, and funding sources and strategies.

Scope of System

Who will use the system? Will it accommodate only municipal agencies, or will it be shared with county, state, and other agencies? Will this be used by municipal departments, such as planning, engineering, police, fire, building inspection, etc.? The decisions made at this point will greatly influence the direction of GIS planning and figuring costs for the system.

An additional consideration is deciding which agency of a shared data base will be the custodian, or the party responsible for updates, maintenance, opening GIS data bases to outside agencies and the public, etc.

Public Access to Records

One of the strongest advantages of a GIS is the ability for the public to access information to a land record through a modem or other means. This can reduce staff time spent assisting the public in accessing records and encourage more citizen participation. On the front end, consider:

- data base security,
- reasonable charges for access (for example, a business or land surveyor might want a computer link to the data base), and
- liability for the information.

Funding Sources and Strategies

This is one of the most fascinating and most challenging components of developing a GIS. Many states now have funding programs and grant incentives to encourage local governments to investigate GIS, but Washington does not have such a program at this point. Vermont was the first state to pass a statewide funding program for developing GIS at the local level. Most recently, Wisconsin passed an increase that will eventually raise the document filing fees at the county register of deeds office from $4 to $10. A portion of the fee increase can be retained locally for a GIS program if there is a land record modernization program in place; the balance of the funds is sent to the state, which awards grants to local governments for GIS activity.

GIS presents the perfect opportunity for local governments to leverage their resources with other public agencies and private groups. Such was the case in Dallas and Indianapolis, where a variety of groups financially supported the effort. The GIS data base will be in great demand by utilities (phone, cable, electric, water, wastewater, etc.), private businesses (developers, surveyors, attorneys, real estate offices, etc.), and other governmental agencies (county, state, and federal). In addition, each of these groups may be able to contribute to the overall integrated GIS program.

Formal agreements regarding data base security, ownership, and levels of anticipated financial or resource contributions can greatly expedite the funding process. These agreements can help accomplish the following:

- reduce existing and future duplication of efforts,
- formalize sharing of staff resources,
- enhance hardware and software, and
- provide a mechanism for records and equipment inventories.

Tennessee Municipal Experiences

Bartlett

Bartlett initially used GIS to digitize all existing topographic and aerial maps (including roads and drainage ditches), plus its 20-year annexation area. This encompassed a 35-square-mile area and required 200 man-hours of digitizing work. The city of 31,000 then developed overlays and compiled information of water lines, buildings, zoning, sewer lines, drainage structures, and floods. Here are some of the tasks Bartlett's system performs:

- locating addresses;
- determining the best locations for schools, fire stations, water towers, lagoons, parks, industrial clients, etc.;
- maintaining sewer, water, and drainage lines;
- locating traffic signals;
- assisting with zoning; and
- routing emergency vehicles.

Bartlett invested $114,500, which includes the cost of conversion work, hardware, software, etc. The city is now able to enhance decision-making through the GIS.

Kingsport

Kingsport uses GIS extensively to provide alternative bus routes, discern land use patterns, track zoning changes, and monitor population growth. GIS also aided the Wal-Mart chain in selecting a site for a retail outlet.

The 1993 project funding totaled $160,000, plus the city has a parcel conversion contract with Johnson City for $40,000. The proposed 1994 operating budget is $66,127, with an additional capital budget of $23,181. The city anticipates that its parcel base for 1993 cost $46,744.

The heaviest city department users of the GIS data base are:

- Finance (utility billing/property taxes),
- Building (street addresses for new construction),
- Planning (property ownership information for annexation and rezoning),
- Water/Sewer (work-order systems),

- Public Works (confirm city address for service requests),
- Library (confirm addresses for library card applications),
- Transportation (street name signs),
- Schools (tuition tracking and school zone address ranges),
- Fire/Police/Central Dispatch (coordinate addresses between 9-1-1, land management, and public safety system).

The heaviest non-city users are:

- Postal Service (automated delivery system),
- 9-1-1 (master street and address guide),
- Kingsport Power (billing system),
- Pizza Hut (automated delivery system),
- United Way (addresses for Kingsport and adjacent Community Chests),
- Business Journal (real estate section),
- Chamber of Commerce (map for sale to public),
- Habitat for humanity (city-owned sites for potential new houses), and
- Board of Realtors (MLS).

The city's applications include: information management, annexation administration, land use planning, zoning evaluation, spatial analysis of crime, emergency vehicle and school bus routing, economic development, park and tree management, infrastructure and transportation planning, property acquisition, solid waste routing, and school district zoning.

The University of Tennessee Municipal Technical Advisory Service further surveyed these cities to determine exactly what type of hardware, software, and costs are associated with municipal applications of GIS. Costs range from a modest $19,000 in Savannah for a base package to an average of $226,277 for Bartlett, Smyrna, and Cookeville. Tables with more detailed information on costs are in Appendix C.

3:P:GIS

Appendix A Definitions and Terms

Accuracy

Degree of conformity with a standard, or the degree of correctness attained in a measurement. Accuracy relates to the quality of a result. If accuracy is relative, the position of a point is defined in relation to another point. It is less expensive to build a GIS in the context of relative accuracy. If accuracy is absolute, the position of a point is defined by a coordinate system. Building a GIS in the context of absolute accuracy requires use of the global positioning system. Accuracy is also referred to as the degree to which the calculated coordinates of a certain feature are close to the true coordinates.

Address Matching

It is often useful to know where a particular street address (e.g., 124 Maple Street) is in terms of its longitude and latitude. Some geographic files (see DIME And TIGER definitions) help the user of a GIS to match a particular address to an approximate x,y coordinate in space. The particular address can then be lit up as a dot on the screen. A collection of such dots can be used to produce a "pin map." For example, one might want to light up dots for all addresses where building permits have been issued in the last six months.

Aerial Photogrammetry

The process of producing maps from controlled aerial photographs.

Aggregation

The summation of attribute data over particular geographic areas. For example, total number of crimes of specific types may be aggregated by census tract.

Attributes

Alphanumeric data related to specific map features (e.g., polygon, line, or point) through a common identifier. For example, a parcel map in which every parcel is related to its own unique identification number may be linked to an attribute data file containing specific information about the parcel (ownership, land use, assessed value, etc.). The match of the specific parcel on the map to its attribute data is completed through the use of its unique identification number. This unique identification number must be included with both the spatial data about the parcel and with the attribute data about the parcel.

Base Map

A map that depicts fundamental map elements to which other "layers" are registered. For example, a base map for a municipality might include streets and parcel boundaries. A separate layer for the water system might be created that is registered (e.g., correctly placed relative to) the base map. This separate layer may be displayed individually or on top of the base map.

Cadastral Maps

Maps used to record ownership interest in land. Such maps are often maintained by tax assessors and include parcel boundaries, easements, and rights of way.

Coordinate Geometry (COGO)

The method of describing map elements based on a series of bearings and distances. This is a digital file that contains the elements of a land survey in a form that can be reconstructed through key board entry. These elements may be entered manually or digitally in the field with special equipment. There are applications programs available that translate the coordinates obtained with the equipment into computer maps.

Data Dictionary

The definitions of data elements ("fields," such as housing type) and the format of those data elements. This information clarifies the "data structure" of the data base. Data dictionaries define each component of the data base. For example, the description of each data field would contain the field's name, its length (i.e., this field takes 10 columns), type of data (i.e., integer or alphabetic), and the meaning of the various values for the field (i.e., 1 equals single family, 2 equals duplex, etc.).

DEM (Digital Elevation Model)

A digital file compiled by the U.S. Geological Survey (USGS) that provides a matrix of elevations at regular grid intervals for areas of the United States. Such elevation data is useful in creating three-dimensional surface representations in a GIS.

Digitize

The process of entering the coordinates of map features by drawing with a cursor on a digitizing table connected to a computer. GIS and other computer software can then make use of the file containing the coordinates of each point of the specific map.

DLG (Digital Line Graph)

Digital files developed by the USGS to represent the information contained on their topographic maps. These files are divided into various layers that include information such as contour lines, railroads, roads, urbanized areas, manmade features, etc.

GBF/DIME File (Geographic Base File/Dual Independent Map Encoding File)

Files prepared by the Census Bureau for each Standard Metropolitan Statistical Area (SMSA). The DIME files contain information about each street segment in SMSAs, including the address ranges on a particular street segment for both the left and right sides of the street. For example, a particular block of Maple Street might have address numbers 104 — 196 on its right side and 103 — 195 on its left side. Also included in the DIME files is information about which census tracts are

to the left and right of each street segment. The DIME files were developed in the 1970s for "address matching" when a particular address (e.g., 120 Maple Street) may be given an approximate latitude and longitude point in space (an x,y coordinate).

Geodetic Control

A set of surveyed features with their location referenced to particular survey monuments. These "control points" are used to register the map to definite positions of the Earth's surface.

Global Positioning System (GPS)

A method of locating points on Earth based on signals from several satellites. GPS is just becoming cost-competitive with traditional survey techniques.

Hydrography

The surface water features that can be shown on a map, such as streams, lakes, oceans.

Layer

A set of map features that can be individually displayed or manipulated.

Local Area Network (LAN)

Linking computers within a few thousand feet of each other with special cables and software through which they can share applications, data, and electronic mail.

Map Projection

A mathematical method by which the real (spherical) surface of the Earth is displayed on a two-dimensional surface (map). The projection methods keep certain geometric relationships true while others are distorted.

Orthophoto

An aerial photo that has had distortions removed so that features are in their correct horizontal position.

Pixel

The smallest unit of resolution of a computer screen. Most screens used for high-level mapping have over a million pixels (1,024 x 1,024 dots).

Planimetric Base Map

Those physical features that can be seen from the air. Typical features include building foot prints, various transportation systems, water bodies, electric transmission lines, fences, etc.

Polygon

A closed, multi-sided map feature, also know as an arc or region.

Scale Conversion

A mathematical process by which measurements are converted from one scale to another. This may apply to converting a map to another scale within the same system or to a different scaling system.

State Plane Coordinates

A set of geographic coordinates that determines the location of a feature in relation to a fixed grid. The grid system is referenced to sea level and is used by most land surveys.

Thematic Map

A map that displays the spatial distribution of an attribute. Usually, a thematic map displays a single attribute (a “univariate map”), such as soil type or land use. For attributes like soil type or land use (“normal” variables), planners generally want shaded maps that highlight regions (“polygons”) by employing different colors or patterns. For other attributes (like population density — a “metric” variable), a planner would like a shaded map in which each shade corresponds to a range of population densities (e.g., the lightest shade corresponds to one to four persons/acre, and the darker shade corresponds to 200 or more persons/acre, and the other shades represent ranges in between).

TIGER (Topologically Integrated Geographic Encoding and Referencing)

Street network developed by the Census Bureau for the 1990 census of population. These files expand upon the older DIME files that covered only portions of the United States. The new TIGER files use digital road networks from the USGS to expand the coverage to the entire country. Like DIME files, TIGER files will be particularly useful for address matching.

Topographic Map

A map that shows ground elevation usually through either contour lines or spot elevations.

Topology

The definition of how map features are related to each other. A system’s ability to define adjacency and connectively will be important determinants of its spatial analysis capabilities.

Utility

A software program designed to perform a simple task, often as part of a larger program. For example, utilities often provided by GIS will translate maps among forms used by different packages.

Zoom

The computer graphic display capability to expand or reduce the size of a picture or map. In a GIS, an analyst might “zoom in” to a city map in order to look at a specific block, and then “zoom out” to compare this block with neighboring blocks.

4:P:GIS

(Village of Schaumburg, Ill.)

I. General

Village staff has explored the field of Geographic Information Systems/Computer-Aided Design Systems, focusing on the ways in which this technology might aid the village's various departments in performing their day-to-day duties. The following guidelines have been established:

a. The primary purpose of the Village of Schaumburg Geographic Information System/Computer-Aided Design System (GIS/CAD) will be to support the day-to-day functions of the staff members of the various departments of the Village of Schaumburg Municipal Government with regards to the use, analysis, and maintenance of spatially oriented information in terms of both graphic and descriptive data.

b. It is fully intended that the GIS/CAD System will operate as a "multi-user" system for the purposes of the design process as well as the actual implementation. However, it is anticipated that the actual system will be procured in stages, most likely starting with single user work stations and expanding to support multiple, simultaneous users, some of whom may be at remote sites.

c. The use of the CAD/GIS system will very likely involve the exchange of data and map files with other GIS and automated mapping systems and, therefore, must be able to efficiently communicate with various other systems, as will be specified, depending upon the system selected for use by the village.

d. It is the intention of the village that the system selected and all data that is to be input be acquired in an economical manner; that the system function efficiently, without extensive use of expensive and unneeded support products being required; yet be fully functional and responsive to the needs of the various departments that will be the users of the system.

II. Scope of Services Requested

This project is intended to be a multi-year, multi-phase event. It is intended that the consultant selected will take the lead role in performing all research; making all oral presentations; preparing a system user's manual; providing in-progress reviews and reports; designing, supervising, conducting, and evaluating all requisite proposal procedures in a timely, efficient, and cost-effective manner; all with the support and guidance of the village's Project Manager, who will serve principally as the liaison between the consultant and the project Steering Committee. In other words, the leg work, questions, and recommendations will be provided by the consultant, the answers and decisions will be provided by the Village.

An additional requirement will be for the consultant to prepare a CPM chart for the project as a whole, and prepare monthly reports on the status of the various aspects of the process, along with recommendations as to how lagging portions of the project might be brought back into line.

The project will progress in four phases, with the consultant's tasks in each phase to be as is enumerated below.

A. Phase I. Needs Assessments/System Design

1. *The undertaking of a complete and thorough GIS/CAD needs analysis for each department of the village government.* The work product of this effort is to be a report that includes, but is not limited to, identifying both graphic and descriptive data needs and uses for each department; a prioritization of the acquisition of the data to serve the various needs; the resolution of the relative accuracy needs of each department; and "blueprints" of "ultimate" database designs that encompass the ability to provide for the acquisition and use of the required data in a structured and efficient manner in the short run, and also provide for the acquisition and use of the required data in a structured and efficient manner in the short run, and also provide for the inclusion of the potential data needs of the future, all while recognizing the widely varying nature of the sources of said data. The village's project manager will coordinate the consultant's efforts in scheduling meeting times and places between the consultant and the various village departments that will be involved in this process.

2. *Providing an analysis and report on the village's existing computer systems for use as a base document for selecting and implementing coordination and compatibility assurance strategies when the GIS/CAD hardware/software system is selected.* The work produced is to be a document describing the existing systems, their potential for inclusion into the proposed GIS/CAD system, and a discussion of potential limitations of the inclusion of the existing equipment into the proposed system.

3. *Conducting a review of existing as-built records, maps, descriptive data files, and any other potential data sources to allow for the identification and establishment of a strategy for the acquisition, reconciliation, input, and manipulation of the graphic and descriptive data that will be digitized to produce the computerized maps and descriptive databases identified in the needs analysis portion of Phase I.* A document will be developed that will describe how the GIS/CAD system will be used, what data will be loaded into it, and what capabilities it should have. This will be an evolving document and will be revised throughout the duration of this project as conditions warrant. The consultant will prepare the strategy in consideration of how transferability of mapped information and textual information (existing and to be developed) between the GIS/CAD system and other GISs should be accomplished; and how to manage, maintain, and update map files while maintaining historical records of the descriptive databases.

4. *Performing reviews of existing hardware/software systems that will meet the needs of and provide for the manipulation of the data that is identified as being required as a result of the need analysis.* The work product will be a "short list" of vendors to which the fully developed RFP will be sent for complete analysis of capabilities, support requirements, and costs. The work product will include a document that essentially is an analysis of the

extent to which a commercially available GIS/CAD system can meet the needs criteria identified during the needs analysis/data acquisition strategy development portions of the project. Important limitations to the respective packages with regards to the village's needs shall be noted.

The consultant will be expected to be generally familiar with reference materials, and to query GIS/CAD vendors and existing system users when necessary. It is recognized that it may be impossible to definitely determine all the capabilities of each package, and, accordingly, the reviews should identify further investigation that may be required at the time of the final FRP for hardware/software acquisition. The ultimate objective of the analysis is to provide a recommendation of one (or more, as appropriate) GIS/CAD system that appears best able to meet the needs of the village's departments.

A minimum of six packages will be reviewed, including Intergraph, Arc/Info, Synercom, McDonnell-Douglas, Land Innovation/Site Comp, plus one to be selected by village staff after consultation with the consultant. By mutual agreement the consultant and the village may decide to analyze different packages, or a different number of packages, than those stated herein.

5. *Preparing a cost estimate and an updated timetable for each upcoming phase of the project and preparing a complete project budget that considers the desired phased approach, the calendar year, and the village's budget cycle.* The budget document shall also identify and estimate costs for potential outside service costs, such as hardware maintenance, additional training, and any post-installation services. The document shall also identify the likely needs of the village with regards to additional personnel for data input and subsequent system operation in terms of man-hour estimates and probable salary ranges for the various classes of additional personnel that might be required. Furthermore, the budget document shall identify potential creative funding strategies as well as potential discount programs for any services or hardware and software purchases.

B. Phase II. Data and Hardware/Software Acquisition

Part 1. Data Acquisition

1. Development and issuance of an RFP complete with all requisite technical specifications for the purposes of contracting with a subconsultant to provide aerial photography services in accordance with the data acquisition strategy identified in Phase I, Section 3.

2. Development and issuance of an RFP complete with specifications for the purposes of selecting a subconsultant to provide conversion of graphic data from the aforementioned aerial photographs (and existing as-builts, where necessary); reconciliation of existing digital graphic data-bases to insure compatibility with the format requirements of the hardware/software system selected; and graphic data digitizing services in accordance with the data acquisition strategy identified in Phase I, Section 3.

3. The general process for each of the above two project subparts will be for the consultant to develop the RFP complete with all pertinent technical specifications; identify potential subconsultants for the required services; distribute the RFP's appropriately; answer offeror's questions; establish selection criteria; etc., up to proposal evaluation. *The village will take the proposals and award the contract.* The consultant is hereby advised that he will be required to take the aerial photography and data conversion consultant(s) as a subconsultant(s). The consultant will consult with the village on the aerial photography and data conversion consultant selections, and will administer those contracts.

Part 2. Hardware/Software Acquisition

1. Development and issuance of an RFP complete with specifications for the purpose of selecting a hardware/software system from the previously developed "short list" of vendors. Hardware/software purchases are expected to be phased with one workstation on line during the first year of the project, with the rest of system to follow per implementation plan to be developed as part of this contract.

2. The general process will be to develop an RFP complete with all pertinent technical specifications, distribute the RFP to potential vendors, answer offeror's questions, establish selection criteria, establish benchmark testing processes prior to final demonstration, arrange for product demonstrations, etc. *The village will take the proposals and award the contract directly.* The consultant will consult with the village on vendor selection and will assist in administering the hardware acquisition contract. The consultant will be responsible for insuring data integrity, system security, system functionality, component compatibility, and the adequacy of the hardware/software configuration for one year from the installation of each phase of the equipment purchased.

3. The consultant shall be responsible for establishing a plan for training system administrators and operators in an economical fashion. This will, of course, depend on the hardware/software system selected and will commence prior to the arrival and installation of the equipment.

C. Phase III. Later-Phase Hardware Acquisition

The consultant shall prepare a detailed plan for the completion of the hardware system in terms of a two-year phased purchase. The consultant shall provide services similar to those to be provided under Section B, Part 2, paragraph 2, above.

D. Phase IV. Post-Installation Service

1. Upon acquisition of a specific hardware/software, it is necessary that the consultant's expertise remain available to the village. A summary report will be written in cooperation with the project manager detailing the process of the system's development, its cost, and what the pitfalls were. The consultant will develop user template designs for specific data entry and manipulation functions.

2. The consultant will prepare complete system documentation in the form of a custom written user's manual, which will be separate from the hardware/software manufacturer's user manual. The manual should include database information and specifics about the system setup, as well as a trouble-shooting guide for commonly noticed problems. Also, the consultant will state an hourly fee to provide additional unforeseen services as may be required, such as additional start-up assistance; database adjustment; six-month functionality review; contract assessment; revision to strategy plan to serve as a guide to the future after a period of hands-on use; recommended additional hardware/software purchases or adjustments; and potential configuration changes.

III. Schedule

[The following is offered so that the readers of this PAS Report will have an idea of the amounts of time necessary for each part of the GIS implementation. Circumstances will certainly differ by jurisdiction and need.]

November 3, 1989	Proposals due back from consultants
December 19, 1989	Contract recommendation to village board
January 1, 1990	Consultant begins project
February 1990	Consultant devises preliminary GIS/CAD data acquisition strategy
March 1990	Reviews of hardware/software systems commence
April 1990	Aerial photography flights are made
May 1990	Consultant completes GIS/CAD needs analysis of all village departments; database design complete
May 1990	RFPs for Phase I hardware/software system out to vendors
July 1990	Phase I hardware/software proposals back from vendors
July 1990	Contract for data conversion awarded by village board
August 1990	Phase I hardware/software system contract awarded by village board
September 1990 October 1990	RFPs for Phase II hardware/software system out to vendors Phase II hardware/software system proposals back from vendors
November 1990	Phase I hardware/software delivered and installed. Available data loaded and tested. Hands-on use begins.
December 1990	Phase II hardware/software contract awarded by village board
May 1991	Phase III hardware/software contract awarded by village board
January 1992	Hardware system fully operational; graphic database complete
January 1993	Descriptive database complete

IV. Format and Contents of Proposal

The proposal shall include, in order, the following contents:

1. Letter of Transmittal
2. A title page, including title of proposal; name and address of proposing organization; name, address, title, and phone number of principal investigator (person primarily responsible for conduct of technical analysis and project management); name, title, and signature of organizational contracting officer.
3. An abstract page, including a one-page abstract or summary of the proposed project. The bottom of the page should state the project cost and duration of the project.
4. A technical proposal, the purpose of which is to indicate the consultant's understanding of and ability to accomplish the work to be undertaken. This proposal need not be elaborate but must include, at a minimum:
    a. A statement and discussion of the project requirements and objectives as perceived by the proposal consultant.
    b. A statement and discussion of the major difficulties and problem areas likely to arise during the selection and implementation of the GIS/CAD system as intended by the village, together with potential or recommended approaches for their resolution.
    c. A statement of any interpretations, qualifications, or assumptions pertinent to or inherent in the technical proposal.
    d. A description of anticipated subcontracting arrangements (if any), including name, address, and qualifications of subconsultant(s), and specification of tasks to be subcontracted. All subcontracts deemed by the village to be significant in nature must be approved by the village through the project manager prior to execution.
    e. Identification of personnel who will most likely be assigned to the project(s), including the extent of availability of key personnel. A project manager will be named and his position, qualifications, responsibilities, and authority defined.
    f. Total estimated price of the proposed services, with a breakdown of costs and expected man hours for each task enumerated under each phase description to the degree such a breakdown is possible. Included should be a listing of the various labor rates by personnel category and an identification of the type and amounts of costs that are anticipated (such as telephone charges, travel, hotels, etc.) to be added to labor and other direct costs for the completion of each project task.
    g. Relevant information on specific factors that qualify the consultant to provide the services necessary. Such information should include:
        (1) Consultant's experience in assisting organizations in using GIS Technology;

(2) Consultant's knowledge of and experience with the various kinds of GIS software that may be considered for use, including, but not limited to, and understanding of problems and solutions involved in converting mapped information between different software and hardware systems;

(3) Consultant's specific knowledge and experience in helping to implement GIS technology in situations involving numerous inconsistent kinds of data sources, especially when the quality of existing resources is not consistently good and the project budget will not allow extensive reconciliation surveys;

(4) A minimum of five installation references, which are to be persons who can advise the village as to the quality of the consultant's performance on projects similar to that proposed herein.

V. Basis for Evaluation

The proposals received in response to this RFP will be evaluated by a consultant selection committee that will include appropriate staff from the village. The proposals will be evaluated according to the following general criteria . . .

1. Experience of the consultant in designing such systems and working with other companies in implementing and operating such systems.
2. Apparent ability of the consultant to provide the services in a timely, prompt manner that meets the established project milestone deadlines.
3. Estimated cost of providing the required services.

5:P:GIS

Bartlett Configuration Information and Costs

Item	Cost	Number	Type
Server	$4,000	1	IBM PC Compat.
Workstation	$50,000	2	Sunsparc2
PCs	$3,500	3	IBM Compatible
Digitizer	$4,000	2	GTCO 3648 L
Plotter	$9,000	2	Calcomp 1043, 1044
Scanner			
Software Cadd Software GIS Software Other	$1,000 $3,000	2 2	Arcview Arc/Info
Other			

Conversion Costs

Conversion Type	Cost	Vendor or In-House (Indicate)	Hours Per Parcel
Aerial Photography	$40,000	Vendor (1/3 of city)	N/A
Digitizing			
Land Survey GPS			
Other			

Smyrna Configuration Upgrade Information and Costs

Item	Cost	Number	Type
Server	$15,146	1	Sunsparc Station IPX
Work Station		1	Sun 19” Monitor
PCs	$14,685	3	Gateway 2000 Crystal Scan
Digitizer	*(Existing)	1	Altek Datatab
Plotter	*(Existing)	1	Oce 1830 Pen Plotter
Scanner			
Software CADD Software GIS Software Other		 1	 Microstation
Other		1 1	Datastor Tape Backup Hp Laser Jet Printer

Conversion Costs

Conversion Type	Cost	Vendor or In-House (Indicate)	Hours Per Parcel
Aerial Photography	*$36,000	Vendor	
Digitizing	*	Vendor	
Land Survey GPS			
Other			

*Existing Original Mapping System Cost About $150,000 ($100,000 Aerial/Digitizing, $30,000 Hardware; $20,000 Training and Software).

Knox/Knox County Configuration Information and Costs

Item	Cost	Number	Type
Server	$850,000	1	Vax 8810
Workstation	$5,000-$40,000 Ea	43	Integraph
PCs	$2,000-$3,000	6	Various
Digitizer	With Work Station	40	Integraph
Plotter	$4,000-$60,000	22	Various
Scanner Software CADD Software GIS Software Other			 Integraph Integraph Integraph Framme
Other			

Conversion Costs

Conversion Type	Cost	Vendor or In-House (Indicate)	Hours Per Parcel
Aerial Photography	$106,000	Vendor	
Digitizing	$2,600,000	Vendor	
Land Survey GPS	Included in Aerial Photo	Vendor	
Other	$150,000/Yr. Updates		

Cookeville Configuration Information and Costs

Item	Cost	Number	Type
Server			
Work Station	$27,000		Model 30 Sun Sparc 10
PCs	$2,000		IBM Compatible 486-33
Digitizer	$4,000		Calcomp 9500
Plotter	$6,000		Nova Jet II 850
Scanner			
Software CADD Software GIS Software Other	$3,500 $27,000		Autocad Rel. 11 Arc/Info
Other			

Conversion Costs

Conversion Type	Cost	Vendor or In-House (Indicate)	Hours Per Parcel
Aerial	*$275,000 (includes digitizing and land survey GPS)	Vendor	
Digitizing		Vendor	
Land Survey GPS		Vendor	
Other			

Savannah Configuration Information and Costs

Item	Cost	Number	Type
Server			
Work Station			
PCs	$5,000	1	Gateway 486
Digitizer	$2,800	1 1	Summagraphics Summacketch Summargraphics Microgrid
Plotter	$2,700	1	Houston Instruments DMP60
Scanner			
Software CADD Software GIS Software Other	$6,000	111	Autocad Rel. 12.C2 Arcad Rel. 11.3 Windows, Excel, Etc.
Other	$2,500		Hp Laser Jet 4, Panasonic DOT Matrix, Paper Copier, Etc.

Conversion Costs

Conversion Type	Cost	Vendor or In-House (Indicate)	Hours Per Parcel
Aerial Photography Digitizing			
Land Survey GPS		P.L.S. — Jackson TN. Western Geophysical Houston, TX	
Other			

6:P:GIS

(City of Rockford, Ill.)

The Washington State Department of Transportation does not endorse or comment on the quality or legality of the following document.

City of Rockford
Rockford, Illinois

Notice to Prospective Vendors, Instructions
Proposal and Specifications
for
Professional Services
for
A Computer-Aided Geographical Information System

City of Rockford
Purchasing Department
City Hall Building
425 East State Street
Rockford, Il 61104

Proposal On:	Computer-Aided Geographical Information System
Proposal No.:	1091-PW-158
Proposal Opening:	Friday, November 1, 1991

CITY OF ROCKFORD, ILLINOIS

425 EAST STATE STREET
61104

CHARLES E. BOX
MAYOR

RONALD MALMBERG
FINANCIAL DIRECTOR

REQUEST FOR PROPOSALS

RFP: 1091-PW-158

The City of Rockford, Illinois, hereby invites sealed written proposals from qualified computer software vendors and other

The City of Rockford reserves the right to accept or reject any and all proposals and to waive technicalities.

If you need further assistance in answering questions as you consider your proposal, please contact Stephen Ernst by phone at 815-987-5577, by fax at 815-987-5562, or write to the City of Rockford, Department of Public Works, 425 East State Street, Rockford, Illinois 61104-1014.

Dated: 10/10/91

FINANCE AND PERSONNEL COMMITTEE

By: Raymond P. Gaziano
Purchasing Manager

RPG/glm

Page 2 of 2 pages

CITY OF ROCKFORD, ILLINOIS

INSTRUCTIONS, SCOPE OF SERVICES AND PROPOSAL FORM

REQUEST FOR PROPOSALS

COMPUTER-AIDED GEOGRAPHICAL INFORMATION SYSTEM

RFP No.: 1091-PW-158

INSTRUCTIONS

1. Sealed proposals will be received in the office of the Purchasing Manager, City Hall Building, 425 East State Street, Rockford, Illinois, until 11:00 a.m., local Rockford time on Friday, November 1, 1991 for a Computer-Aided Geographical Information System as detailed in the Scope of Services hereto. At that time and place all proposals received will be publicly opened and read aloud.

2. The person, firm or corporation making a proposal shall submit it in a sealed envelope to the Purchasing Manager or his duly designated representative at the office of the Purchasing Manager on or before the hour and day stated above.

3. Each firm shall affirm that no official or employee of the City of Rockford, Illinois, is directly or indirectly interested in the proposal for any reason of personal gain.

4. No proposal may be withdrawn or modified in any way after the deadline for opening of proposals.

5. Each firm shall submit with their proposal the information specified in the proposal documents for compliance with the laws of the State of Illinois on Fair Employment Practices and with the City of Rockford's Ordinance on Equal Employment and Business Opportunity. Any proposal which fails to include the compliance items properly completed will not be read and will not be considered.

Page 1 of 2 pages

6. The City of Rockford, Illinois, reserves the right to accept or reject any and all proposals and to waive technicalities. The City will make its award within 90 days from the date of opening proposals. This request does not commit the City to award a contract, to pay any costs incurred in preparation of a response to this invitation, or to procure or contract for services or supplies.

7. If there is any question whatsoever regarding the Scope of Services, it shall be the proposer's responsibility to seek clarification immediately from the Purchasing Manager.

8. These instructions are to be considered an integral part of any proposal.

9. Seven (7) copies of the proposal shall be submitted.

DATED: 10/10/91

FINANCE AND PERSONNEL COMMITTEE

BY: Raymond P. Gaziano
Purchasing Manager

RPG/glm

Page 2 of 2 pages

Scope of Services

Objective

The city of Rockford hereby requests proposals from firms to provide technical assistance, software and hardware to implement a Geographical Information System (GIS System). The proposal should cover all aspects of GIS System implementation as detailed below.

Is it the intent of these Specifications to permit the widest possible participation of all qualified, responsible firms for the GIS System. Any reference, dimensional details, model identifications, or any other technical data given herein which may suggest a particular hardware manufacturer or software vendor are given solely to establish a desired standard of quality and performance to afford an equitable comparison of proposals received.

Proposal Organization

1. *Proposal Summary* — a synopsis, prepared for management review, covering the salient features of the proposed GIS System and any other general recommendations or observations which the vendor believes is pertinent.
2. *GIS Vendor Profile* — a brief summary of the vendor's organization and staff, including the vendor's contact person, any annual reports, company brochures, recent new releases or newsletters, etc.
3. *GIS System Technical Proposal* — a detailed description of the proposed GIS System's hardware and software components, according to the requirements as detailed below.
4. *Support Services Proposal* — a detailed description of the GIS vendor's support for installation, implementation, hardware and software maintenance, documentation, training and user support.
5. *Price Quotation Schedule* — a schedule of prices for the various hardware and software components or modules as detailed below. Because the number of workstations and individual workstation software modules will be determined during the Site Assessment phase an exact Price Quotation will not be possible. Schedules should be complete so that comparison of an "ultimate" workstations system or network can be evaluated.
6. *Customer References* — at least five (5) workstation-based city or county government references who are already using the vendor's software. To the

extent possible the list of references should be for similar size cities or counties as compared to the city of Rockford and Winnebago County.

7. *Exceptions* — an optional statement of exceptions to the terms, conditions, and/or specifications as detailed in this RFP.

Project Schedule

Deadline for Receipt of Proposals	November 1, 1991
Review of Proposals/Possible Interviews	November 15, 1991
Contract Negotiation	December 20, 1991
Anticipated Project Initiation	December 30, 1991

Review of Proposals

Once the proposal has been received and opened, the city will review the material and, if needed, request an interview. The city will then negotiate a contract with their first choice. If, for some reason, it is not possible to reach agreement on a fee or the terms of the contract, the city will then terminate the negotiation and consider their second choice.

Respondents shall be required to comply with all applicable laws of Fair Employment Practices and Equal Employment. They will affirmatively ensure that, in any contract entered into pursuant to this advertisement, minority and/or women business enterprises are afforded full opportunities to submit proposals in response to this invitation and will not be discriminated against on the grounds of race, national origin, color, sex or age for consideration for any award.

Project Phasing

The project will be phases so as to allow continuous flow with the selected vendor over several budget years. The phases shall be as follows:

Phase I	Review of GIS Software Proposals/Vendor Selection
Phase II	Site Assessment/Project Analysis Report
Phase III	Pilot Project
Phase IV	Full Scale Implementation (multi-year)

Central System Project

The city of Rockford is currently reviewing proposals for a central system computer and software to address the following applications:

Accounts Payable	Fire Data Base	Permit & Inspections
Accounts Receivable	Fire Incident Reporting	Water Utility Billing
Activity Tracking	Parking Tickets	Payroll
Budgeting	Personnel	Local Taxes
Cash Receipts	Project Tracking	Service Request/Work Orders
Cost Accounting	Purchasing	General Ledger
Fixed Assets	Portfolio Management	Land Parcel Data Base

The proposals being evaluated by the city encompass the following hardware platforms (OS listed in parenthesis); Hewlett-Packard (UNIX), IBM (AS 400) and Unisys (MCP). It is anticipated that the Land Parcel Data Base will contain a variety of alphanumeric fields of information that the GIS System will need to interface with, as detailed in Section 4. Vendors requiring further information should contact Mr. Jim Coffey, Data Processing Director at 815-987-5539.

Winnebago County GIS Project

The county of Winnebago is currently funding a project for cadasteral mapping of the entire county, which includes all parcels in the city of Rockford. The mapping consultant will be providing all deliverables in digital format as DXF files (see Section 3.7.4). The cadasteral information will contain, but not be limited to, the following:

Roadway Right of Way
Railroad Right of Way
Parcel Boundaries
Section/Township/Range Boundaries
Easements
Lakes, Rivers, Streams and Channels
Parcel Identifier (Tax Code, Lot, Block, etc.)
Street Names

It is beyond the scope of this document to detail all of the elements of this mapping project. Vendors should address questions to Mr. Eugene Quinn, County Recorder of Deeds, at 815-987-3100.

Detailed Specifications

Purpose

The purpose of these specifications is to describe software for a computer-aided geographical information system (herein referred to as "GIS System") in order to permit qualified firms to propose to the city of Rockford. The multiuser GIS System shall be similar or equal to software and hardware products offered by Prime/ComputerVision Corporation, Intergraph Corporation, Ultimap Corporation or approved equal. The core of the GIS System shall be a topologically structured, seamless, object-oriented graphic data base with exceptional revision control capabilities running in a networked, workstation-based hardware environment.

Project Phasing

The project will be phased so as to allow continuous flow with the selected vendor over several budget years. The phases shall be as follows:

Phase I	Review of GIS Software Proposals/Vendor Selection
Phase II	Site Assessment/Project Analysis Report
Phase III	Pilot Project
Phase IV	Full Scale Implementation (multi-year)

1 GIS System Functionality

1.0 General

The GIS System shall support simultaneous design, editing, processing, printing and plotting by multiple users. The GIS System shall support workstations in a local area network (LAN) and wide area network (WAN) environment and shall be capable of supporting peripherals on these workstations as well as permitting access to data on other processors.

The GIS System shall provide for security maintenance, including access control and database protection. The GIS System shall also provide date/ time stamping of all graphic features so that the GIS System can recreate the data base at any past point in time.

1.1 Integrated Mapping/Facilities Management Data Base

The GIS System shall treat a data base as an integrated collection of graphic and nongraphic information with both types of data accessible for all interactive input, edit and output operations.

The GIS System shall maintain a master map database. The GIS System shall allow up to 99 different alternatives to the master map database to be concurrently active without affecting the permanent master map database. Any and all of these changes must be able to be used to update the master map database following approval at a later time.

All updates to the master map database shall be instantly available to all users. All changes and additions to the master map database must be automatically date/time stamped at the object level, such that historical views of the data can be retained and retrieved for future use.

The data base for the attribute information shall be relational. The attribute data base software may be different than the graphic data base. However, the two shall work interactively.

1.2 Data Base Access/Design

The GIS System shall provide the following minimum data base access/ design features:

1.2.1 System Table Operations which allow checking on system parameter tables for schema, command mnemonics, symbols, line styles, annotations, and attribute annotations, that are active, and change any or all of them at any time.

1.2.2 Global data base access.

1.2.3 Data Base Structure

- Relational data base structures to provide maximum flexibility in use and applications.
- A data base language that can be operated interactively or called by programs.
- Extensive user control over the structure of the data base, selectivity and flexibility of output, adaptability to changing standards, and a mechanism for tailoring the GIS System to specific functions in terms of ease of use, security, etc.

1.2.4 Data Structure and Storage

- A user-definable data base schema.
- User-definable subsets of the total data base, such as symbols and line types, which may be used by different groups for different applications.
- A user-modified data base framework prior to commencement of building of the data base.
- Grouping of data elements with similar characteristics into homogeneous data types, on which the data structure can be based.
- Geographic division transparency to the end user.
- Arbitrary access to any map, district or other area in the data base.
- Graphic and nongraphic software working in conjunction to aid the free flow of data within the GIS System. For example, the centroid of a previously created polygon (parcel) is electronically indicated (picked) to the GIS System. In response, previously entered attribute information for the parcel is displayed on the screen (property ID, owner, address, etc.).
- Combinations of nongraphic attribute data on maps displayed as attribute annotation.
- User-definable messages attached to user-definable fields.
- Internal functions which check data base integrity after a system crash or power failure recovery.
- Simultaneous access on the same data without concern for data integrity.

1.2.5 File Management

- A list of files for the operator, who can then select any of the various types of files, i.e., maps, plot files, macros, etc.
- A complete copy of any existing map which can be re-filed under a new name specified by the user.
- New files created from merging two or more files together. The merged files shall then be stored in the data base.
- Deletion or renaming of existing maps in working or permanent storage.
- Date/Time stamping of all graphic changes, permitting the user to reconstruct the graphic data base at any point in time after the initial installation date.

1.3 Program Integration

The GIS System shall provide the means to integrate programs or subroutines written by the user. The means to integrate the user programs or subroutines shall provide the following minimum features:

1.3.1 Access to the graphical and nongraphical information in the data base for purposes of reading and writing data base files.

1.3.2 Access to the data structure of the mapping data base for the purpose of determining how and where the data base is stored on the disk.

1.3.3 Full control of the dialogue between an interactive graphic workstation and the user's program, including the ability to display alphanumeric text and graphics on the workstation screen, and to accept keyboard, mouse or digitized inputs from the workstation.

1.3.4 Access to other system input/output devices from the user's program, e.g., disk, magnetic tape, printer, plotter.

1.3.5 Read and write access to variables created or used by macro procedures so that further processing can be done on these variables.

1.3.6 Access to a programming language provided on the GIS System.

1.4 Map-Related Operations

The GIS System shall provide the following minimum map-related features:

1.4.1 Continuous Spatial Access to Map Information

- Data storage retrieval schema shall permit the user to view, plot, query, report on, and/or edit selected graphic or nongraphic data within any arbitrary area of the continuous data base.
- The GIS System shall allow specification of an arbitrary area as an irregular polygon for any user-defined boundary.
- The GIS System shall store by name, areas enclosed by boundaries for data retrieval, viewing, queries, area overlay analysis, etc.
- The GIS System shall allow a user to perform map access operations without knowing which or how many maps are involved.

1.5 Survey Control

The GIS System shall provide the following minimum survey control features:

1.5.1 Map Control

- Establish proper location based on two or more known monuments.
- Establish control based on rectangular X and Y axes.
- Update the coordinates in the attribute file when a control monument is adjusted. Other attribute information for that control monument and reference point shall remain unchanged.
- Measure and display coordinate and distance values from a data base map.
- Accept field-surveyed State Plane Coordinates input from the keyboard for monument points on a map with random alignment on the digitizer.
- Maintain relative horizontal position accuracy.
- Reference geographic points as State Plane Coordinates, Latitude/ Longitude, UTM coordinates, U.S.G.S. coordinates, or N.G.S. coordinates and convert between these reference systems without affecting the permanent data base.

1.5.2 Map Grid

- Enable, disable and display grid lines at user-specified intervals on the State Plane grid.
- Display grid lines based on section and quarter section points.
- Enable and disable grid lines based on user specified X and Y intervals.

1.5.3 Map Processing

- Add the contents of one existing map to another existing map, using any or all data types.
- Create a new map consisting of a specified area to be extracted from an existing data base map, using any or all data types.
- Provide a warping routine that adjusts length and direction of all lines relative to an adjusted control monument.
- Automatically edge match features of the same data type along a user-defined boundary.

1.6 Edit Operations

The GIS system shall provide the following minimum edit operation features:

1.6.1 General

- Edit any graphic or nongraphic data element in the data base.
- Have a security system to restrict the update/edit of certain data to specified users. However, this data shall remain viewable by all other users, unless restricted by additional security parameters.

1.6.2 Changes to Nongraphic Data

- Append, modify, input new values for, or delete one or more nongraphic attributes of a selected element of any data type.
- Retroactively insert on or more data fields of any kind of attribute annotation for any selected data type which has associated nongraphic attributes.
- Update nongraphic data independently from or in conjunction with graphic data.
- Modify the data base by adding and removing files and/or attribute fields within files.
- Turn any nongraphic attribute into graphic annotation.
- Display or print a list of the nongraphic attribute values for a selected element in any data type, subject to current data selection criteria specified by the user.

1.6.3 Map Access for Display and/or Editing

- Provide an index or menu of existing files.
- Recall data base maps or drawings for updates.
- Access any polygonal or previously defined area in the permanent data base using a user-defined search key, such as street name, address, intersection, subdivision name, etc.
- Recall, display and allow editing of two or more contiguous data base maps.
- Reflect new attribute values immediately and automatically in any map displays of information entered through the attribute data base. For example, if the diameter of a water pipe is shown as six inches, a change in the value of this nongraphic attribute to eight inches must cause the annotation to change to eight inches as well.
- Provide a viewing system for display access of the entire map, giving the user basic map orientation. The user then specifies a window to display a smaller subset of area with more detail, and continues the process until it is reasonable to display all data elements in a specific area. Reasonable would be when all data elements are readable.

1.6.4 Data Related Operations — Input of Nongraphic Attributes

- Automatically create an attribute record to user-defined guidelines for point, line and polygonal features, such as ID numbers, line lengths and polygon areas and perimeters.
- Enter Nongraphic attributes while digitizing the corresponding graphic element, at a later time, or through a batch process.

1.6.5 Data Related Operations — Output

- Rotate map displays as defined by the user.
- Display attribute annotations associated with any specified map features.
- Display the names and values of attributes as attribute annotations.
- Display data from data base in English or metric units.
- Display alphanumeric fields from data base.
- Select any data to display/plot.
- Display/plot any or all data, types or elements within the current window on the screen, subject to data selection criteria and display control parameters as specified by the user.

1.6.6 Area Related Operations

- Save any polygon currently in use under a user-specified name for subsequent retrieval.
- Retrieve by name a saved polygon and its contents.
- Delete a saved polygon by name.
- Create a symbol which is centrally located in the polygon when the polygon is created.
- Perform an overlay operation on two or more polygons by name to generate a resultant polygon using Boolean operators AND, OR, NOT.
- Perform polygonal retrieval of any desired collection of data from the permanent data base that lies exclusively inside, or exclusively outside the polygonal boundary.

1.7 User-definable Mechanisms

The GIS System shall provide the following minimum user-defined features:

1.7.1 A mechanism that defines that data structure for the mapping data base, logically broken into families or data types.

1.7.2 Mechanisms that defines the graphical appearance of all symbols used to represent map features which occur at a point, as well as symbols which appear as part of linear or curvilinear features or patterns.

1.7.3 A mechanism to define the graphical appearance of all line styles used to represent linear or curvilinear map features.

1.7.4 A mechanism to define the graphical appearance of all lettering styles used to represent textual map features.

1.7.5 A mechanism to define the graphical appearance of each character in any given text font so that upper and lower case characters and special characters can be used.

1.7.6 A mechanism to define, for each data type or layer, combinations of nongraphic attribute values which may be displayed on maps as an attribute form of annotation at the user's discretion.

1.7.7 A mechanism to define, for each data type or layer, various conditional actions which the GIS System can take to automatically validate the graphical and nongraphical consistency of new data being input to the date base, such as a layer or data type that will only accept capital letters, two decimal points or a certain line type.

1.7.8 Default mechanisms supplied and set up on the GIS System by the vendor. The GIS System shall allow the defaults to be modified by the user.

1.7.9 Provide as a minimum the X and Y coordinates for every point and store in the graphic data base. The GIS System shall allow the Z coordinate to be entered and stored in the attribute data base.

1.8 User Interface

The GIS System shall provide the following minimum user interface features:

1.8.1 Provide a user interface for use by people without an extensive background in using computers.

1.8.2 Provide commands that can be entered via an alphanumeric keyboard.

1.8.3 Create restricted or limited sets of available command names for security purposes and/or to simplify operation for selected users.

1.8.4 Create and subsequently modify an unlimited number of operational menus of user design.

1.8.5 Activate and deactivate menus from the keyboard, mouse or digitizer.

1.8.6 Provide keyboard and mouse/digitizer menu commands to perform the same functions.

1.8.7 Issue prompt messages to guide the operator in successfully executing commands.

1.8.8 Suppress prompt messages if desired.

1.8.9 Allow viewing of the workstation configuration, e.g., default values, current map(s) in use, scale of map, etc.

1.8.10 Provide on-line help, available to the user at all times. Help should list all available commands and explain their purpose and use.

1.8.11 Provide for multi-tasking, preferably through a multiple window environment in which at least 50 windows can be displayed simultaneously.

1.8.12 Provide for playback, allowing users to review all graphics operations.

1.9 Macro Capabilities

Macro capabilities shall be provided so that the user can create automated procedures of a complex or repetitive nature. The GIS System shall provide the following minimum macro features:

1.9.1 Execute any standard command supported by the vendor's interactive software and the ability to execute operating system commands.

1.9.2 Execute nested macros.

1.9.3 Perform standard arithmetic computations, such as add, subtract, multiply, divide, square root and exponentiation, and display the result.

1.9.4 Perform conditional and unconditional branching based on the comparison of expression values (e.g., equal to, greater than, less than, and not equal to).

1.9.5 Include comments for explanatory purposes.

1.9.6 Assign values to variable strings.

1.9.7 Use values of macro variables within the vendor's mapping software and/ or within user-written programs to access the mapping data base.

1.9.8 Assign values of macro variables to nongraphic attributes in the data base.

1.9.9 Enable and disable system messages during execution.

1.9.10 Call a library of mathematical functions.

1.9.11 Concatenate alphanumeric strings.

1.9.12 Convert numeric values to string values.

1.9.13 Set decimal precision for purposes of calculation, internal variable storage or output display of values of variables and expressions.

1.9.14 Store values computed in interactive operations as variables which can be used for other purposes.

1.9.15 Set decimal precision of 1 to 8 decimal places for variables used in macros.

1.9.16 Invoke or execute user-written programs in the same way as any standard command or function.

1.9.17 Trace output of the commands executed in a macro.

1.9.18 Create a macro from input supplied by a text file.

1.9.19 Call subroutines written in high level language, e.g. Pascal, C, Fortran, etc.

1.10 Geoprocessing Analysis Tools

The GIS System shall provide the following minimum geoprocessing analysis features:

1.10.1 Access and manipulate data base information to create two-dimensional thematic maps by assigning patterns or colors to polygons which represent similar information.

1.10.2 Overlay data elements to create an integrated data element and then assign a new descriptive attribute that is user-defined.

1.10.3 Merge boundaries of related polygons.

1.10.4 Include boundary generalization to perform area and perimeter analysis, point-in-polygon analysis (overlay points on a polygon and relate polygon attributes to the points which fall within that polygon), and line-in-polygon analysis. (The line must be wholly within the polygon for line-in-polygon analysis.)

2 Graphics Creation

2.0 General

The GIS System shall use graphics commands that are consistent for all software functions and modules. This section shall define those operations that allow the user to create and modify graphics, such as points, lines, circles, arcs, polygons, predefined symbols, and text.

2.1 Data Structure

The graphic database must include points, lines, curves, annotations, polygons, alignments, and networks. As a general rule these graphic elements must be able to be generated by table digitizing, stereodigitizing, screen digitizing, transferring/translation, scanning, etc.

The graphic data base must be seamless and continuous, and capable of storing up to 4 billion graphic objects, without manipulation of tiles or facets required by the user in order to view or work with a particular area of interest. This seamless feature shall cover the entire city of Rockford while maintaining resolution conducive to the accuracies required for the performance of engineering applications.

The graphic data base shall be “object-oriented”, which shall allow all features to be contained within a single database scheme, without manipulation of layers or levels by the user. Objects desired for graphic displays must be definable by name, family, and the nongraphic attributes associated with the features.

Graphic features must be able to be associated with nongraphic attribute descriptions, as follows: Each graphic object must be able to be linked to multiple attributes, some of which may reside on a remote computer, and other attributes which reside on the workstation. The remote attributes shall be able to be linked to and used by the GIS System in real time without downloading, transferring, or copying data.

The topological structure for graphic data is defined as a structure in which the spatial connectivity and adjacency relationships between graphic elements (points, lines, curves and areas) are implicitly defined. The topology shall represent curves according to their true geometry, as opposed to approximating the curves with two-point lines. The GIS System shall allow a polygon to be modified by bending or flexing its sides with having to rebuild the topology definition.

2.2 Graphic Entry

The GIS System shall provide the following minimum graphic entry features:

2.2.1 Points

The GIS System shall allow points to be entered as follows:

- By command to determine and enter the coordinates of a cursor location.
- By entering the coordinates via the keyboard.
- By specifying the distance and direction or azimuth from the previous point.
- By specifying the distance, direction and angle relative to a given line from a previous point.
- By specifying the distance and direction along a line configured from a previously defined point on the line.
- By defining the intersection of straight lines and/or circular arcs.
- By defining the point of tangency between a straight line and a circular arc or between two circular arcs.

2.2.2 Lines

The GIS System shall allow:

- Straight lines to be entered by defining its endpoints by any means discussed in the Specifications.
- A line to be entered tangent to a given point on an arc or circle if the desired point of tangency is identified, and the approximate end point of the tangent of the line is established. The GIS System shall be able to define a tangent to an arc of a circle from a point outside the circle if the beginning point is identified and the approximate position of the point of tangency is established.

- The user to perform automated line snapping of the end points of new lines to end points of existing lines of similar or different line types.
- The user to define line type (solid, dashed, etc.) and the line weight.

2.2.3 Linestrings

The GIS System shall allow linestrings, defined as a series of connected lines or curves, to be entered as follows:

- By entering sequentially each straight line segment endpoint within the linestring, optionally interspersed with selections of other straight lines.
- By identifying existing lines to make a linestring.
- By entering its vertices, optionally interspersed with selections of other than straight lines, and a stop command that automatically selects the first vertex and closes to it (closed linestring).

2.2.4 Parallel Lines

The GIS System shall allow the user to create lines parallel to previously defined straight lines or linestrings. The user shall determine the spacing of parallel lines either graphically or by the keyboard.

2.2.5 Perpendicular Lines

The GIS System shall allow the user to construct a line perpendicular to a given straight line or to the tangents of any curve.

2.2.6 Rectangles

The GIS System shall allow the user to enter a rectangle by entering the two opposite vertices. The edges of the resulting rectangle shall be parallel to the X and Y axes.

2.2.7 Contours

The GIS System shall allow the user to create a contour designated as a linestring or spline which appears as a visibly smooth series of curves. The GIS System shall close said contour back to the first vertex is designated by the user.

2.2.8 Circles

The GIS System shall allow circles to be entered as follows:

- By entering the center point and a radius length.
- By entering the center point and a point on the circumference.
- By entering three points on the circumference.
- By entering two endpoints of a diameter.

2.2.9 Circular Arcs

The GIS System shall allow arcs to be entered as follows:

- By entering the beginning, one intermediate point and the end point.
- By entering the radius length or the diameter length and the beginning and ending points.
- By entering the center radius, the arc direction and one of the following: either the arc length, chord length or the central angle.

2.2.10 Grids

The GIS System shall allow the user to specify a working grid which is aligned to a coordinate axis whose origin is defined by the user. The whole grid, portions of the grid or tick-marked grid intersections may be displayed. The user shall have the option of selecting whether or not all points will be snapped to the nearest point.

2.3 Data-Related Operations

The GIS System shall provide the following minimum data-related features:

2.3.1 Selection

Select any data type or data element for entry, editing or output purposes, and activate all or any combination of data types for display or other processing purposes.

2.3.2 Entry Control

- Enter symbols or annotation strings with one or two digitized points at a user-defined orientation.
- Input maps at any scale, and digitize from originals that are at any scale.
- Snap to a point and close a polygon. Snapping to a point results in the exact placement of an object to a selected point. The “closing a polygon” feature connects the last point entered in a string to the first point entered.
- Draw to the end or origin of any entity by just selecting the entity.
- Insert any entity, text or dimension in a minimum of 16 different colors.

2.3.3 Linear and Curvilinear Data Entry

- Enter variable line types, line weights and colors.
- Create, store and display an automatic connection of digitized line segments in a string.
- Copy points and lines to another data type and copy them from one layer to another.
- Perform batch or interactive input.
- Include a full function, full screen editor for batch files.
- Accept alphanumeric point descriptions.

2.3.4 Crosshatching

- Insert crosshatching in any predefined area.
- Define the type of crosshatching to be used. The user shall specify the font, spacing and angle of crosshatching.
- Trim automatically to the edges of the predefined area. The crosshatching shall be omitted, if desired, from blocked sections inside the predefined area.

2.3.5 Symbol Entry

- Scale and rotate symbols during entry and edit operations.
- Change symbol scaling while keeping the map scale constant or keep the symbol size constant while varying the map scale.

2.3.6 Annotation (text) Entry

- Justify text based on at least the following points: lower left, lower center, lower right, center left, center, center right, upper left, upper center, upper right.
- Center text or force fit between two digitized points, with options to allow the text to retain its spacing or its character height.
- Justify annotation strings entered with two digitized points, such that the text can be justified from its lower center, upper center, center, lower right, upper right or center right and still appear centered between two digitized points at normal size.
- Change annotation scaling while keeping map scale constant, or keep annotation size constant while varying map size.
- Scale and rotate text at the time of entry or edit.
- Select text font, angle, height (point), width (pitch), slant or justification.
- Place the annotation parallel to any entity (line, circle, arc, etc.).
- Replace, move or delete an annotation or any part of an annotation.

2.3.7 Centerline Entry

- Specify a width (distance between expanded lines) to be assigned to centerline data.
- Attach elevation data to centerline points.

2.3.8 Dimension Entry

- Select various types of dimension configurations including simple interior and exterior dimensions with and without extension of leader lines, dimensions with leader line on one end only, angular dimensions, reference dimensions, and the possibility to nest or stack dimensions.
- Compute dimension values automatically or input values manually.

- Define arrow length, leader line length and leader line gap for dimensions entered from the keyboard or with two digitized points.
- Insert notes or labels with arrows pointing to a particular entity or area on the drawing.

2.3.9 Coordinate Geometry (COGO)

- Determine areas of given defined objects with line and curve segments and state the results on the screen.
- Display distances and bearings between two identified points.
- Provide a means of inputting existing data from survey notes.
- Input curves by any combination of geometric values required as a minimum to define the curve and derive any other parameters.

2.4 Edit Operations

The GIS System shall provide the following minimum edit features:

2.4.1 Changes to Graphic Data

- Move a point in any data type to a new location.
- Change a data element and redefine a layer for it if it was previously undefined.
- Move a point and automatically move all lines that use that point to the new location.
- Rotate all or selected symbols or text elements of any data type within a user-defined rectangular area or polygonal areas.
- Transform all or selected elements of one or more data types with a user-defined area by applying factors of translation, rotation and scaling as defined by the user.
- Redefine the appearance of a symbol and have the changes be global throughout the data base.
- Create copies of selected elements in a drawing file leaving the preexisting copy unchanged.
- Match common graphic elements across an arbitrary line within a drawing file or when merging.
- Define the origin point, translation distance in X and Y, rotation angle, and scaling factor for transformations.

2.4.2 Trimming of Entities

- Extend or shorten an existing entity (line, circle, arc, etc.) by selecting the entity with a cursor, establishing one new end point with the cursor, establishing its other end point either with a cursor or by entering its numeric length.
- Extend or shorten either or both ends of an existing entity to the intersection of any other defined entity by selecting one end of the

entity and the entity to which it should be trimmed and then selecting the entity that the second end should be trimmed to.
- Clip digitized data to the boundaries of a polygon, i.e., lines digitized which cross the boundary, should be clipped so that the part inside the polygon is saved in the map data base and the other part is ignored, or vice versa.

2.4.3 Deletion Functions
- Delete the last element or series of elements entered in the current data type without the necessity for the user to select the element(s).
- Delete a selected element of any data type.
- Delete all or selected elements of all data types inside a user-defined rectangle or polygonal area.
- Perform verification (requiring yes or no response from the operator) of delete functions.
- Close spaces caused by deletions in text.

2.5 Display Operations

The GIS System shall provide the following minimum display features:

2.5.1 Windowing
- Define a window by picking two opposite corners on the screen.
- Define a window to view the complete map.
- Define a window by digitizing the center and specifying a radius.
- Define a window by digitizing the center and specifying a viewing scale, e.g. 1: = 100'.
- Define a window by specifying a plat page number, a range and township number, or state plane coordinates.

2.5.2 Verification
- Measure angles between lines, distances between entities, distances between specific locations and distances along curves.
- Verify line segments by displaying the coordinates of both end points, the length of the line and the bearing of the line.
- Verify circles by displaying the radius and the coordinates of the center.
- Verify arcs by displaying the radius, the coordinates of the center and the coordinates of both end points.
- Verify the default values for text, layer, grids, etc.

2.5.3 Utility Functions

- Include an interactive set of utility functions to allow graphic design and/or modification of character font tables.
- Include an interactive set of utility functions to allow graphic design and/or modification of character symbol tables.

2.5.4 Help Facility

- Include a HELP facility with a directory of available commands explaining the purpose and use of any commands in the GIS System.

3 Additional Features

3.1 Computer-Aided Design (CAD) Functions

The GIS System shall provide the following minimum CAD features:

3.1.1 General

- Calculate and/or accept distance and percent of slope for cross section data.
- Calculate and/or accept offset and elevation.
- Calculate and/or accept offset and rod readings.
- Calculate and/or accept profile on base line stations.
- Accept and reduce data from a Lietz-SDR 2 Data Collector.
- Generate cross sections from digitized contours.
- Calculate and/or accept horizontal offset distance. HI and level rod readings.
- Calculate and/or accept cross section by radial offset distance and elevation.

3.1.2 Horizontal Alignment

- Accept placement of centerlines, curb lines and other detail lines.
- Create simple, compound or reverse curves.
- Display distances between any two points.
- Define and display exiting information simultaneously with designed/ proposed information for the same area.
- Edit alignment and curve length.
- Compute offsets automatically from baseline to alignment line.
- Compute and display horizontal curves from any combination of given and unknown.
- Interactively change any curve or dimension parameter.

3.1.3 Vertical Alignment

- Handle symmetric curves.
- Utilize the following equation for computing symmetrical curves: Length = K(A/G), where A = grade I — grade 2/2L and: Elevation at X = (elevation PVC) + (G1)(X) + (A)(X)(X).
- Edit vertical curve length.
- Compute curves with any combination of given and unknown and display the same.
- Calculate and display elevation at any point.
- Adjust grade.
- Allow grade breaks.
- Display two or more profile lines.
- Display existing and design elevations at any point.
- Display existing versus planned cross section based on horizontal alignment.
- Store standard template definition files for use on any project.
- Define and modify templates.
- Allow 900 variable (points, grade) templates.
- Calculate catch points automatically.
- Design symbols to indicate surfaces for different materials.
- Generate digital terrain models (DTM).
- Plot cross sections based upon interpolation of the DTM.
- Interpolate new cross sections between known cross sections.
- Design intersections.

3.2 Numeric Computations

The GIS System shall provide the following minimum computation features:

3.2.1 Geodesic Computations

- Compute the area of a closed figure in units specified by the operator. Minimum units required are square feet and acres.
- Compute the distance and azimuth or bearing of each course of a traverse, and the area if the traverse is closed, provided that the traverse beginning and end points are identified.
- Compute the perimeter of any identified closed figure.
- Compute the distance and bearing between two specified points.
- Compute the perpendicular distance to a straight line from a given point.
- Compute the numeric radius of an arc and display it along with the coordinates of the center of the arc.
- Compute the perpendicular distance to the tangent of any regular or irregular curve from a given point.

- Initiate macro procedures in the same way as standard system commands or functions or invoke macros from a menu.

3.2.2 Coordinate Geometry (COGO)

- Input land parcels by metes and bounds descriptions and incorporate the parcels defined by this metes into the map data base.
- Perform area and boundary closure calculations.
- Adjust control points and automatically move the resulting points and data that were originally registered to that point. For example, when a known control monument coordinate is updated and positioned on the GIS system to reflect this, the points places relative to that monument, such as subdivision coordinates, are also adjusted.

3.2.3 Earthwork Computations

- Calculate average end area of cross sections.
- Produce reports showing station, cut volume, fill volume and balance.
- Produce mass haul diagrams and balance points.
- Apply shrink swell factors.
- Correct for aligning curvatures.
- Allow for manual correction of end areas by zero end areas or repeat end areas.
- Allow for manual input of borrow or waste quantities.
- Plot cut and fill depths at grid points.
- Allow the definition of numerous design alternatives on terrain.
- Mix and match alignments, profiles and templates.

3.3 Output Operations

The GIS System shall provide the following minimum output operation features:

3.3.1. Output Control Parameters

- Enable displays to be clipped exactly to the boundaries of any user-specified polygon.
- Allow the user to specify a factor for changing the scale of symbols, annotations, and line symbology at display time with no modification to the data base.
- Select continuous dashing for crosshatching, so that line patterns line up across different polygonal areas.
- Display existing ground cross sections for check.

3.3.2 Working Drawings

- Generate a working drawing involving any or all data types.
- Automatically place the contents of a saved working drawing into a data base map at the user-defined location, orientation, angle and scale factor.
- Set the scale factor for a working drawing when it is placed into a data base map.
- Clip vectors which cross the user-defined boundaries of a working drawing so that the portion of these vectors inside the boundary become part of the working drawing.
- Construct working drawings with the same scheme as the main data base.

3 3.3 Plotting Software

- Generate plot files over user-specified areas, at user-defined scales, from any map or maps in the data base, using normal selection and display commands.
- Display plotter error messages.
- Display or plot all or selected text in a drawing.
- Queue plots for continuous serial plotting.
- Plot graphic and nongraphic data simultaneously.
- Produce a plot directly from the permanent data base at a user-specified scale, covering any polygonal area, which may cross map boundaries and involve many maps.
- Display and/or plot the entire continuous data base, at any scale, using any or all data types.
- Plot plan/profile sheets.

3.4 Workstation Control Parameters

The GIS System shall provide the following minimum workstation control features:

3.4.1 Define any rectangular area of the digitizing surface for tracking the motion of the cursor or the screen.

3.4.2 Make a detailed log of all workstation activity for printing.

3.4.3 Turn on or off system messages coming to the workstation at any time.

3.4.4 Stop the workstation at any time, thus terminating a work session.

3.4.5 Use local graphic workstation commands to activate a point of origin ("rubber band") for tracking of the last digitized point, erase the display, request hard copies, and perform other workstation related functions.

3.4.6 Zoom in (increase viewing scale) or zoom out (decrease viewing scale) in repeated user-defined or predefined steps and reset to the original view at any time.

3.4.7 Pan (move around map, viewing repeatedly different areas of the same size) by defining a "pan window" on the screen, within an area displayed, and then moving the pan window to different locations.

3.5 Report Generation

The GIS System shall provide the following minimum report generation features:

3.5.1 Provide the ability to extract any user-defined subset of information from the data base for the purpose of generating printed reports.

3.5.2 Manipulate the data and print reports in user-defined formats.

3.5.3 Extract sets of nongraphic attribute information from the data base and organize the results into files suitable for generation of printed reports.

3.5.4 Extract from the data base any nongraphical information for any specified data types or any polygonal area, and display this information of the screen and/or in printed format, according to user-specified graphical and nongraphical selection criteria.

3.5.5 Generate all on screen reports without leaving the graphic (map) environment. Report information should be displayed in a user-specified window.

3.6 Query Requirements

The GIS System shall provide the following minimum query features:

3.6.1 Provide a fourth generation language (4GL) which is used for query operations.

3.6.2 Select features for query by attribute, location or by selection criteria consisting of Boolean operators or mathematical expressions.

3.6.3 Search for map features by location, an attribute or combination of attributes.

3.6.4 Create graphic displays and/or reports based on query results.

3.6.5 Generate all queries without leaving the graphic (map) environment. Query information should be displayed in a user-specified window.

3.6.6 Provide software and hardware connections and data servers to allow IBM PC/AT, or compatible, with VGA minimum graphic ability workstations, to act as query terminals only. Update and edit functions do not have to be available on the PC style terminal.

3.7 Miscellaneous Features

The GIS System shall provide the following minimum additional features:

3.7.1 English/Metric Conversion

- Specify the base units to which the stored data base coordinate are referenced, as either English or Metric.
- Use a simple command to switch from the base system of units to another system of units so that all input and output coordinates and measurements are automatically interpreted and presented to the user in the desired system of units.

3.7.2 Security

- Prevent unauthorized access and/or manipulation of files.
- Provide passwords for specified security levels including access to the mapping software.
- Use menus as a type of security feature, such as having menus limited to certain types of data, menus limited to certain commands, or menus for read-only access to the data base.

3.7.3 Data Backup

- Provide an historical record of the data base alterations with the date and time the operation occurred, connection time and disk I/O time.

3.7.4 Data Exchange Formats

- Import and export data in DXF format.
- Import coordinate data in ASCII format.

3.7.5 Proximity Searches

- Includes radius search operations to determine the number of occurrences of a given feature within a selected distance from a point.

3.7.6 Buffer/Corridor Searches

- Allow buffers around points and polygons to be created for geographic analysis.

4 Interfaces

The GIS System shall be capable of communicating with various other hardware and software platforms that the city of Rockford may currently be using or will be using in the future. The vendor shall detail all communication protocols supported and specify all current interface methodology. Vendors should detail all capabilities offered by the various methods of supported communication, such as Update vs. Inquiry, Printing, Use of a Hot Key, etc. Vendors must specifically address the following issues:

4.1 Mainframe Connection

The GIS System shall be capable of connecting to a medium sized mainframe computer. As mentioned in the Scope of Services vendors shall detail a live, interactive connection to Hewlett-Packard, IBM and Unisys mainframes. Live, interactive shall mean that no copying or downloading of data from the mainframe to the GIS workstation is required. This shall not be construed to indicate that it will never be desirable to download large data sets for certain communication intensive applications. To the extent possible vendors should list existing clients using a data server and/ or protocol converter connection to these platforms. The preliminary Land Parcel Data File layout to be located on the mainframe is shown below.

Parcel Identifier	Subdivision Plat	Year of Construction
Parcel Address	Section/Township/Range	Total Square Footage
Owner Name	Census Tract/Block	Number of Units
Owner Address	Legal Description	Number of Employees
Owner Phone Number	Ward/Precinct	Product (SIC Code)
Occupant Name	Current Zoning Class	Building Dimensions
Occupant Phone Number	Year 2010 Plan Designation	Date of Annexation
Water Folio Number	Current Land Use	Historic Status
Assessed Valuation	School District	City Council Action(s)
Fire Protection District	Structure Type	Code Violation(s)
Hazardous Material	In/Out of City	Permit/License History

4.2 IBM PC/AT Connection

The GIS System shall be capable of connecting to a stand-alone PC/AT, or compatible, computer. The connection shall be accomplished on an RE-232 channel without the use of modems, assuming that the PC/AT and the GIS workstation are within close proximity. The connection shall provide the capability of retrieving data from the PC/AT, similar to the mainframe, with no intervention from the PC/AT required. The connection shall also provide the capability of using the PC/AT as a graphic terminal within the GIS System network. All software and hardware required for this functionality shall be described. To the extent possible vendors should list existing clients using a data server and/or protocol converter connection to the PC/AT platform.

4.3 Workstation Wide Area Network

Vendors should detail the functionality of a workstation wide area network, where locations remote to the main workstation network access the GIS System. For instance, the 911 Control Center is located in a different building from City Hall, but the GIS System users may be located in the 911 Control Center. Vendors should explain all possible methodologies to accomplish this interactive connection and the pros and cons of each. If possible, vendors should provide performance benchmarks of the various options.

5 Data Conversion

Vendors shall detail the approach and cost to convert the digital map files to be provided by the county of Winnebago. Costs may be by parcel or by map file. Conversion shall include reading of the DXF files, rubber-sheeting of the DXF environment into a topologically structured, seamless graphic data base. Costs should include manual entry of annotations from the DXF map files if the conversion does not provide it directly. The vendors should also detail procedures for future updating of the graphics data base as they become available from the County.

6 Hardware

The GIS hardware shall comply with the requirements listed in this section. Vendors shall provide a description of the proposed components of the system, including the manufacturer and model number. Further details, spec sheets, etc, shall be included as appropriate. The hardware configuration shall be a fully distributed computing architecture utilizing local area network (LAN) technology.

6.1 Local Area Network (LAN)

The LAN shall provide the following capabilities:

- The LAN must support an Ethernet cable/protocol which must operate at a minimum speed of 10 megabits per second.
- The LAN must allow each workstation to have a locally installed hard disk, but must support diskless workstations if desired.
- The LAN must be capable of supporting hundreds of workstations on a single network with no noticeable degradation in performance.
- The operating system must allow any user on any workstation to have transparent access to and use of data on any other workstation disk drive.
- The operating system must support automatic concurrency control across the distributed workstations, meaning that there can only be one concurrent edit of a file with many concurrent reads.
- No file server must be required to support these operations.

6.2 Workstations

The workstations shall provide the following capabilities:

- Operation in a normal office environment.
- Multi-tasking, virtual memory workstations which are capable of networking with each other to allow transparent access to data, programs, and peripheral devices at any site by the users of the network.
- 32-bit processors similar or equal to the Motorola MC68040.
- Minimum CPU clock speed of 25 Mhz and be rated at 22 MIPS processing power.
- Main memory from 8 to 64 MB and disk storage from 200 MB to 4 GB.
- Support a minimum of three (3) RS-232 devices.
- Include an Ethernet controller and software.
- Include a detachable keyboard and mouse for entering commands and manipulating graphics.
- Include a color, bit-mapped graphic monitor with minimum 19” CRT display capable of a minimum resolution of 1280 x 1024 pixels. The monitor shall be of supporting 8 color planes and display at least 256 colors simultaneously from a palette of at least 16.7 million colors.

6.3 Peripherals

The workstations shall provide the following peripheral capabilities:

- Cartridge tape unit for backup and software loading with a minimum storage of 60 MB per cartridge. The cartridge must allow for network-wide backup to be performed from a single workstation, including any or all data from any or all hard disk drives in the network.
- High density tape backup in the form of 4mm Digital Audio Tape (DAT) with a minimum single capacity of 1.3 GB. DAT shall include an integral SCSI controller, cables and driver software.
- A minimum 300 dots per inch (dpi) high speed laser printer. Laser printer shall include cables and driver software.
- 16 button cursor, backlit digitizing table with a minimum dimension of 36” x 48”. Digitizer shall have a minimum accuracy of 0.01 inches. Table shall include an option for a power lift base.
- CalComp 1023 pen plotter, or equivalent, including CalComp controller for the generation of vector plots.

7 Support Services

7.1 Training

7.1.1 The Vendor shall provide a detailed description of all training available for the GIS System. The description shall include:

- Location of each training session.
- Cost for each training session per individual on an hourly basis. Training needs will later be identified during the Site Assessment phase.
- Duration of each training session.

7.1.2 Classroom instruction and hands-on experience shall be provided on equipment similar to that which the City will purchase.

7.1.3 The vendor may provide on-site training.

7.1.4 Travel and per diem for city of Rockford personnel shall not be included in the training quotation.

7.2 Documentation

7.2.1 Documentation, such as a technical reference manual, that describes the operational characteristics and construction of the hardware to enable the performance of routine maintenance and troubleshooting operations.

7.2.2 Software documentation that includes installation procedures, implementation, operation, user instructions and programming documentation.

7.2.3 Two sets of documentation (user's manuals) containing user and operator instructions and commands per workstation.

7.2.4 Revisions to manuals or completely revised manuals to the city of Rockford for one year from the contract date.

7.2.5 Two sets of GIS System administration procedures.

7.2.6 Two sets of operating system manuals.

7.3 Ongoing Support & Maintenance

7.3.1 All hardware items proposed shall include a 90-day, on-site parts and labor warranty, preferably from the original equipment manufacturer.

7.3.2 All software items shall include a similar 90-day warranty.

7.3.3 Monthly maintenance options shall be detailed by vendors fro GIS System software beyond the warranty period.

7.4 Delivery & Installation

7.4.1 Delivery of system shall be within 60 days of an official contract which includes hardware and software items. Delivery schedules for the Project Analysis Report to be negotiated. Installation shall be on-site at the explicit direction of the city of Rockford.

8 Site Assessment and Project Analysis (Design) Report

8.1 Site Assessment

The vendor shall perform an on-site assessment of the city of Rockford departmental needs and desires in regards to the GIS System. The vendor will at a minimum meet with each Department Head and/or selected staff for a minimum of 1/2 day. The assessment time shall be sufficient for the vendor to prepare a Project Analysis Document which accurately reflects the city of Rockford needs and wishes.

The Site Assessment shall detail overlapping Departmental needs which can benefit from resource sharing. In these cases the vendor will make a judgment as to which Department should have control in the best interest of GIS implementation.

The Site Assessment shall provide a detailed priority list of applications to be built during the Pilot Project phase and their associated costs, both contractual amounts to the vendor as well as staff time to be devoted to the application building process.

The Site Assessment shall provide a detailed framework for the Pilot Project phase, including anticipated time lines.

8.2 Project Analysis (Design) Report

The Project Analysis (Design) Report shall provide a detailed discussion of the Site Assessment and shall cover, but not be limited to, the following topics:

- Graphic Database
- Attribute (nongraphic) Database
- Relating graphic and nongraphic data
- Attribute data access
- Applications — Graphic and Attribute Reporting
- Pilot Project Strategy
- Primary Data
  - Photogrmmetric Features
  - Graphic Symbol Dictionaries
  - DXF Conversion of Source Files
  - DXF Translational Tables
  - Horizontal Control
  - Reference Numbering
  - Picture Definition
  - Digitizing Methods and Priority Scheduling
  - Parcel Boundaries and Street Addresses
  - GIS Procedures (entry, edit, update, etc.)
  - Departmental Data Responsibilities
  - Graphic Tagging
  - Data Servers to Mainframe Equipment
  - Data Servers to PC Equipment
  - User Interfaces
  - Interface to 911
  - Access Requirements/Security
  - Basic Applications/Resource Sharing

Advanced Applications
Database Construction
Skill Levels of Future Users

Proposal Requirements for Equal Employment Opportunity

All firms seeking to do business with the city of Rockford are required to submit with any formal, sealed proposal, the following documents:

1. Equal Employment Opportunity Affirmative Action Plan Statement of Policy.
2. The Statement of Non-Compliance and Certificate of Non-Segregated Facilities.
3. The Contractor or Vendor Workforce Data Form listing all current employees, by classification, directly employed by the firm.
4. Your State of Illinois Pre-Qualification Certification Number, issued by the State Fair Employment Practices Commission, entered in the place provided therefor.

If you do not yet have State Pre-Qualification (Item #4), you may, in lieu thereof, enter in the place provided on Page 6 of the EEO forms, your commitment to make application therefor within 30 days from the date of Proposal opening.

Any proposal which fails to include the four items listed above with your sealed proposal will not be read and will not be considered.

Any questions pertaining to E.E.O. requirements should be addressed to the Equal Opportunity Compliance Officer, Ernie Webster, at 425 East State Street, Rockford, Illinois 61104. Phone: (815) 987-4986

Proposal On: Computer-Aided Geographical Information System

Proposal No.: 1091-PW-158

EEO/pgl

Appendix E Catawba County Scorecard

This weighted scorecard was used by Catawba County, North Carolina, to select finalists in its search for a GIS Vendor.

Selection Criteria		
Technical		70 Points
Past Experience	15	
Equipment	15	
Personnel (staff & management)	15	
Methodology	15	
Present Workload	10	
Pricing		30 Points
Technical		
Past Experience		
• All phases of a job this size	15	
• Most of the phases of a job this size	10	
• One-half of the phases of a job this size	5	
Equipment		
• Everything needed for project is state-of-the-art	15	
• Most of everything needed for project is state-of-the-art	10	
• One-half or less of everything needed for project is state-of-the-art	5	
Personnel (staff and management)		
• Sufficient manpower and management with much experience	15	
• Majority of personnel with extensive experience	10	
• One-half or less of personnel with extensive experience	5	
Methodology		
• Good understanding of specifications, with well documentedapproach to project	15	
• Moderate understanding of specifications with good technical response	10	
• Questionable technical response	5	
Present Workload		
• Enough open time for this project	10	
• Questionable amount of time for this project	5	
Pricing		
• Round prices off to the nearest decimal of 1 million (2.12 million = 2.1, 3.07 = 3.1)		
• Subtract rounded number from 30 (30 — 2.1 = 27.9)		
Tally all points for selection of short list. Shortlisted bidders will be required to present oral presentations to selection committee.		

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Appendix F Municipalities With GIS/Resources

This list provided by GIS vendors:

City of Auburn
Planning and Community Development
25 W. Main Street
Auburn, WA 98001-4998
(206) 931-3000

City of Bainbridge Island
Public Works Department
625 Winslow Way E
Bainbridge Island, WA 98110
(206) 842-7633

City of Bellevue
11511 Main Street
Bellevue, WA 98009-9012
(206) 455-6800

City of Bellingham
Public Works Department
210 Lottie Street
Bellingham, WA 98225
(360) 676-6900

Benton County
Central Service Department
620 Market Street
Prosser, WA 99350
(509) 735-8388

Bremerton-Kitsap County Health District
Bremerton, WA

City of Chehalis
Public Works Department
800 NE Cascade Avenue
Chehalis, WA 98532
(360) 748-6664

Chelan County Assessor's Office
Washington & Orondo Streets
Wenatchee, WA 98801
(509) 664-5365

City of Cheney
609 Second Street
Cheney, WA 99004
(509) 235-7211

Clallam County
223 East 4th
Port Angeles, WA 98362
(360) 417-2333

Clark County
1200 Franklin Street
Vancouver, WA 98666-5000
(360) 699-2292

Cowlitz County
GIS Department
County Administration Building
207 Fourth Avenue North
Kelso, WA 98626
(360) 577-3016

City of Des Moines
Engineering Department
21630 11th Avenue S.
Des Moines, WA 98198
(206) 878-4595

City of Dupont
303 Barksdale Avenue
Dupont, WA 98327
(206) 964-8121

City of Ephrata
121 Alder SW
Ephrata WA 98823
(509) 754-4601

City of Everett
3002 Wetmore
Everett, WA 98201
(206) 259-8700

Ferry County
350 East Delaware
Republic, WA 99166
(509) 775-5232

Grays Harbor County
100 West Broadway
Montesano, WA 98563
(360) 249-3842

Hazel Dell Sewer District
Vancouver, WA

City of Issaquah
Public Works Department
135 E. Sunset Way
Issaquah, WA 98027-1307
(206) 391-1000

Jefferson County
1820 Jefferson Street
Port Townsend, WA 98368
(360) 385-9105

King County
County Courthouse
516 Third Avenue
Seattle, WA 98104
(206) 296-7300

City of Kirkland
123 Fifth Avenue
Kirkland, WA 98033-6189
(206) 828-1100

Kitsap County
614 Division Street
Port Orchard, WA 98366
(360) 876-7164

Kitsap County Consolidated
Housing Authority
Silverdale, WA

Kitsap Regional Planning Council
Port Orchard, WA

Kittitas County
Public Works Department
205 West 5th Avenue
Ellensburg, WA 98926
(509) 926-7624

City of Lacey
420 College Street SE
Lacey, WA 98509-3400
(360) 491-3214

Lewis County
Planning Department
351 NW North Street
Chehalis, WA 98532-1900
(360) 740-1433

City of Longview
Data Processing
1525 Broadway
Longview, WA 98632-7080
(360) 577-3300

City of Lynnwood
19100 44th Avenue W
Lynnwood, WA 98046-5008
(206) 775-1971

Mason County
Courthouse Bldg. I
411 North 5th.
Shelton, WA 98584
(360) 427-9670

City of Mercer Island
Department of Engineering
9611 SE 36th Street
Mercer Island, WA 98040-3732
(206) 236-5300

City of Mill Creek
Engineering Department
15728 Mill Creek Blvd.
Mill Creek, WA 98012
(206) 745-1891

City of Mountlake Terrace
23204 58th Avenue W.
Mountlake Terrace, WA 98043
(206) 776-1161

Okanogan County
Planning and Development
149 3rd North
Okanogan, WA 98840
(509) 422-7275

City of Olympia
900 Plum Street SE
Olympia, WA 98507
(360) 753-8325

Pacific County
300 Memorial Avenue
South Bend, WA 98586
(360) 875-9320

Pierce County
County/City Building
930 Tacoma Avenue South
Tacoma, WA 98402
(206) 591-3711

Pierce Transit
Tacoma, WA

Port of Tacoma
Tacoma, WA

City of Port Orchard
216 Prospect
Port Orchard, WA 98366
(360) 876-4407

City of Port Townsend
540 Water Street
Port Townsend, WA 98368-5724
(360) 385-3000

City of Poulsbo
Planing Department
19050 Jensen Way NE
Poulsbo, WA 98370
(360) 779-3901

City of Redmond
Planning Department
15670 NE 85th Street
Redmond, WA 98073-9710
(206) 556-2900

City of Republic
Planning Department
987 S. Clark Avenue
Republic, WA 99166
(509) 775-3216

Sammamish Plateau
Water and Sewer District
Issaquah, WA

City of SeaTac
17900 International Blvd., Suite 401
SeaTac, WA 98188
(206) 241-9100

City of Seattle
600 4th Avenue
Seattle, WA 98104
(206) 386-1234

City of Shoreline
17544 Midvale Avenue N.
Shoreline, WA 98133
(206) 546-1700

Skagit County
700 South Second Street
Mount Vernon, WA 98273
(360) 336-9370

Skamania County
240 NW Vancouver Street
Stevenson, WA 98648-0790
(509) 427-9400

Snohomish County Community Transit
Information Services
Lynnwood, WA

Snohomish County Information Services
GIS Division
Everett, WA

City of Spokane
808 W. Spokane Falls Blvd.
Spokane, WA 99201
(509) 625-6250

Spokane County
West 1116 Broadway
Spokane, WA 99260
(509) 456-3696

Spokane County Health District
Spokane, WA

Town of Steilacoom
1715 Lafayette Street
Steilacoom, WA 98388
(206) 581-1900

Stevens County
215 South Oak Street
Colville, WA 99114
(509) 684-7575

City of Sumas
433 Cherry Street
Sumas, WA 98295
(360) 988-5711

City of Sumner
1104 Maple Street
Sumner, WA 98390
(206) 863-8300

City of Tacoma
747 Market Street, Suite 220
Tacoma, WA 98402
(206) 591-5000

Thurston Conservation District
Olympia, WA

Thurston County
2000 Lakeridge Drive SW
Olympia, WA 98502
(360) 786-5410

City of Tumwater
555 Israel Road SW
Tumwater, WA 98501
(360) 754-5855

City of Vancouver
1313 Main Street
Vancouver, WA 98668-1995
(360) 696-8200

City of Walla Walla
15 North 3rd
Walla Walla, WA 99362
(509) 527-4522

City of Wenatchee
129 S Chelan
Wenatchee, WA 98807-0519
(509) 664-3300

Whatcom County
311 Grand Avenue
Bellingham, WA 98225
(360) 676-6790

City of Yakima
129 N. 2nd Street
Yakima, WA 98901
(509) 575-6000

Yakima County
128 North Second Street
Yakima, WA 98901
(509) 574-1100

Legislative Evaluation and Accountability Program
Olympia, Washington

Washington Employment Security Division
Olympia, Washington

Washington Public Power Supply System
Satsop Plant
Elma, Washington

Washington State Attorney General's Office
HITS Unit
Seattle, Washington

Washington State County Road Administration Board
Olympia, Washington

Washington State Department of Agriculture
Olympia, Washington

Washington State Department of Ecology
Olympia, Washington

Washington State Department of Fish and Wildlife
Olympia, Washington

Washington State Department of Health
Olympia, Washington

Washington State Department of Information Services
Olympia, Washington

Washington State Department of Natural Resources
Olympia, Washington

Washington State Department of Revenue
Tumwater, Washington

Washington State Department of Social and Health Service
Olympia, Washington

Washington State Department of Transportation
Olympia, Washington

Washington State Emergency Management
Olympia, Washington

Washington State Employment Security
Olympia, Washington

Washington Energy Office
Olympia, Washington

Washington State Joint Legislative Redistricting Office
Olympia, Washington

Washington State Library
Olympia, Washington

Washington, State of DCTE
Olympia, Washington

Washington State Office of Financial Management
Olympia, Washington

Washington State Patrol
Olympia, Washington

Washington State Republican Caucas
Olympia, Washington

Washington State Senate
Olympia, Washington

Washington State Geographic Information Council

http://www.wa.gov/gic/gic.html

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Appendix G Further Reading

A Partial List of Sources

Periodicals

Journal of the Urban and Regional
Information Systems Association (URISA)
Journal Division
University of Wisconsin Press
114 N. Murray Street
Madison, WI 53715

Business Geographics
155 E. Boardwalk, Suite 250
Fort Collins, CO 80525

GIS World
155 E. Boardwalk, Suite 250
Fort Collins, CO 80525

American City & County
P.O. Box 5111
Pittsfield, MA 01203-9830

ARC News
Environmental Systems Research Institute, Inc.
380 New York Street
Redlands, CA 92373-8100
909-793-2853

Books

GIS World Sourcebook
ISBN 1-882610-18-0

Profiting from a Geographic Information System
ISBN 0-9625063-7-0

An Introduction to Urban Geographic Information Systems
ISBN 0-19-506535-2

The Power of Maps
ISBN 0-89862-493-2

Fundamentals of Spatial Information Systems
ISBN 0-12-438380-7

Geographic Information Systems
ISBN 82-9911928-3-8

Geographic Information Systems
A Guide to the Technology

ISBN 0-442-00756-6
Geographic Information Systems

A Management Perspective
ISBN 0-921804-91-1

Geographic Information Systems
An Introduction
ISBN 0-13-351123-5

The GIS Book
ISBN 1-56690-047-6

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